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An Overview on Air Cushion Vehicles

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Abstract

To traverse various environments where conventional vehicles could not enter, one was forced to focus on other methods of propulsion and transportation. This category also ranges air-cushion vehicles. With the discovery of radio waves, the researchers realized that this phenomenon has many practical uses, one of them being remote control vehicle.

In this paper, the main purpose was to present an overview on air cushion vehicles, emphasizing the construction and control performances. The vehicle presented in this paper was designed to prove the viability of radio controlling and of the construction having the locomotion based on means of dragging on an air pillow.

Key words: *vehicles, waves, control systems.*

Introduction

Locomotion is the process by which a body that is capable of movement changes its position in a given environment by activating certain factors or forces of his body.

In order to best perform this function, people invented various types of vehicles that allow transporting goods or travel in certain environments with superior performances of its system of locomotion. To traverse various environments where conventional vehicles could not enter, the people must seek typical methods of propulsion and transportation, such as cushion vehicles.

Air-cushion vehicles are relatively easy to drive, but have certain features that make them substantially different from other land vehicles or boats. First, there is no friction with the ground, which means that a gradient descent will be inclined at very high speeds if the pilot is not careful. Maneuverability is also different and channeling left or right, as air cushion vehicles tend to slip because of inertia.

Since there is no solid contact with the ground, they can do 360 degree turns while moving in a straight line. This maneuver is easily accomplished with a model built specifically for speed or large transport, and not having enough power [3].

Slippery platform offered by the air layer gives to the air cushion vehicle unique amphibious capabilities, which allow crossing of floor types that would be bogged down for other types of vehicles on land or sea [4].

History

The first practical model for air-cushion vehicles was derived from a British invention in the 1950's. They are now used throughout the world as specialized carriers, applications for disaster relief, coastguard, military and sports, and passenger services.

Large versions are used to transport hundreds of people and vehicles across the English Channel while others have military applications, such as transport of tanks, soldiers and large equipment in media and hostile terrain. There have been many attempts to understand the principles of high pressure air under the hull and wings. To a large extent, most of the vehicles that use these principles may be called vehicles with "ground effect" or vehicles with "water effect". The main difference is that a hovercraft can lift while standing still, while most of the other models require forward motion to create lift. These "surface effect vehicles" are known in specific cases as ekranoplane vehicles and hydrofoils (figs. 1 and 2). These types of vehicles were the first who used the principles underlying the operation of air-cushion vehicles [2].

Fig. 1. Vehicle hydrofoils

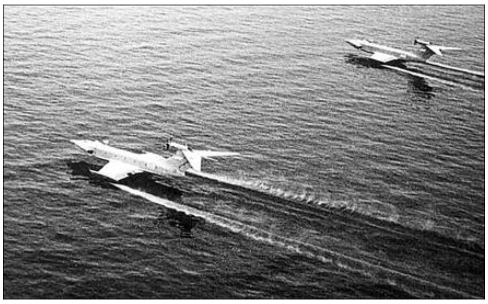

Fig. 2. Ekranoplane

The first historical mention of the concepts regarding surface effect vehicles were given by the Swedish scientist Swedenborg in 1716.

Modern air cushion was invented by Christopher Cockerell in 1956. The theory behind air-cushion vehicle was originally tested in 1955 using empty cat food boxes placed inside a coffee box, a blower and a pair of kitchen scales. Group Cockerell was the first to develop the use of a circular ring of air to maintain the cushion, the first to develop a successful model skirt, and the first to demonstrate that an air cushion vehicle may be used practically.

Cockerell finally managed to determine National Research and Development Corporation to finance the development of a large scale model. In 1958, NRDC has made a deal with Sauders Roe for the development of what would become the SR.N1, short name for "Sauders Roe, Nautical 1" [4].

SR.N1 was powered by a 450 hp Alvis Leonides engine to power a vertical fan in the middle of the ship. In addition to providing air lifting, some of the air flow in the two channels was disposed on each side of the vessel, which could be directed in order to provide thrust. In normal operation, this extra airflow was directed back to pushing forward the vehicle and was blown over two large vertical rudders which provided directional control. For maneuverability at low speed, additional power can be directed forward and differential rotation.

After considerable experimentation, Denys Bliss, from Hovercraft Development LTD, has brought a considerable improvement to the model skirt. His idea was to use a single sheet of bent U-shaped rubber which led to increased performance. With these improvements, air cushion vehicles have become an efficient transport system for high speed services on shallow water and on land, which has led to their widespread development for military, search and rescue, and commercial operations.

Uses of Air-Cushion Vehicles

Commercial uses

Several attempts have been made to adopt the technologies on air cushion rail systems, in order to use these small shear forces for the delivery of the goods at high speeds. The most advanced example of this was Aerotrain, an experimental high-speed train air cushion built and operated in France between 1965 and 1977. Due to lack of funds, project has been abandoned in favor of the TGV, considered by the French government as a solution for high-speed ground transportation.

Uses for search and rescue operations in flooded areas

Around the shallow areas and tidal mud or sand seas frozen lakes, it is virtually impossible for conventional boats to provide a comprehensive search and rescue service. These courts, however, are ideal territories for air cushion vehicles. Many operators, including Coastguards Canada and Kuwait, t found air cushion vehicles to be a vital asset to their rescue operations varied [3].

Uses as mobile medical clinics

In order to achieve a health clinic in the remote and inaccessible corners of the globe, air-cushion vehicles may be the only solution. Air cushion vehicles offer cabins clean, safe and spacious rooms that are equipped with the latest medical equipment to save healthcare professionals. These devices, together with space provided medical clinic in an ideal form, have the ability to be placed anywhere [3].

Uses for ice rescue operations

Air cushion vehicles can be modified to operate at temperatures below zero and are used throughout the world, including the Guard Costal Swedish, Estonian border guards, coast guard of Canada, Crowley Alaska, and border guards in Finland.

Air cushion provides an ideal solution for ice rescue operations, at the same time with limiting the risk to the rescuer. The ice is very difficult to cross by normal vehicles, and air cushion can move with lightning speed high above it and above the snow, offering the fastest way to save victims fixed in ice vessels.

In Finland, small hovercraft vehicles are widely used in maritime rescue and during “mud season” as vehicles linking archipelagos.

Uses in military purposes

The first air cushion vehicle used for military purpose was SR.N1, built by Saunder Roe in the Isle of Wight, UK and used by UK military forces. To test the use of vehicles hovercraft in military applications, in UK there was established the Interservice Hover Trials Unit.

During the 1960’s, in the USA, Bell licensed and sold Saunders Roe SR.N5 as Bell SK-5. They were sent to fight in the war in Vietnam by the United States Navy as a patrol craft in Delta Mekong, where their mobility and speed are excellent for the given delta conditions.

The Soviet Union was world’s largest developer of military hovercraft vehicles. Their range of models varies, from air-cushion vehicles and comparable to SR.N6, to monstrous Bison LCAC – the largest air cushion vehicle in the world.

Craft air cushion provides an ideal platform for surveillance. Conventional boat must remain wide and is exposed to air freely visible to all. Air cushion vehicles can make the transition from a beach or river beds dried to solid ground being effective for making covert surveillance continues. Air cushion vehicles are also ideal as a mobile command post that can be equipped with weapons, radio stations, surveillance equipment and even anti-aircraft weapons.

A Proposed Model of Air Cushion Vehicle

A mobile platform is the part which actually performs the movement. It is composed of two subsets: the propulsion and steering assembly and the air bag assembly (fig. 3).

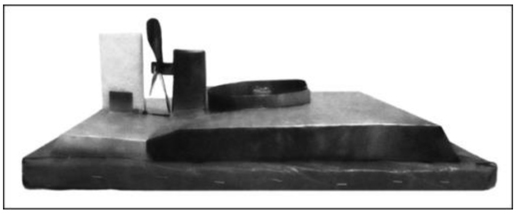

Fig. 3. Mobile platform

During the assembly operation, the hovercraft platform where most of the electronic parts are placed, is suspended on a layer of air trapped under it and is used a "skirt".

The propulsion and steering consists of the following components: command and control module; switch; DC motor that drives the fan used for propulsion; DC motor which drives the rudder; batteries power.

The main component of propulsion and steering system is the command and control module. It receives impulses received from the remote control and turns them into instructions for performing DC motors propelling and directing [1].

Vehicle movement is accomplished by a continuous current motor used to drive a fan that is designed to propel the vehicle forward or to the brake.

The engine, therefore, has two directions of rotation: in clockwise, one that pushes air behind the vehicle, and one counterclockwise, pushing air backwards. Reversing the direction of rotation of the engine braking is used to produce it as long as the vehicle is moving or going in reverse when the vehicle is at rest.

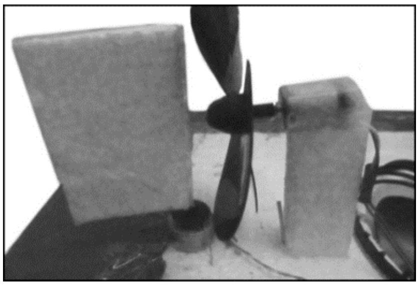

Fig. 4 Propulsion and direction

Behind the fan there is a second DC motor on the axis which is located helm. This is to direct the flow of air from the fan to the drive part which allows the vehicle to move to the left or to the right. The rudder is made of polystyrene, a weight and the lightweight material that may be shaped in any form (figure 4).

To optimally redirect air from the fan propulsion, the form is chosen as a wing. The engine has two one-way rotations to clockwise and the other one as counterclockwise rotation, each giving effect to the right direction of the vehicle and respectively left.

At the base there are two delimiters rudder to limit its travel, so that the angle of the vehicle has an optimum turnout. If delimiters are not placed on the body of the vehicle when the rudder would rotate 90 degrees, the vehicle would have a large angle of turnout.

Electronic assembly along with the two DC motors is connected in series with a switch and the power source. The switch is used to control the power supply from the battery. It is a specific command and control subassembly that allows independent switching assembly to other parts.

Power is on 3 AA alkaline batteries connected in series. Each battery has a capacity of 1.2 volts with a total 3.6 volts which is sufficient to power both the electronic and the two DC motors.

Hovercraft subassembly consists of the following components: a motor that drives a fan (fig. 5), a switch and a battery that provides power. The role of the motor is to lead a fan to blow air under the vehicle platform where it is captured by the skirt. The engine has a single direction of rotation and connected to a switch which enables independent switching of it. This configuration has the advantage that the operation of the air cushion is independent of the other sets which allows the vehicle to float when stationary.

The vehicle is made in this configuration to give greater mobility. Engine power is given by a 9 volt alkaline battery connected in series with the switch and the motor.

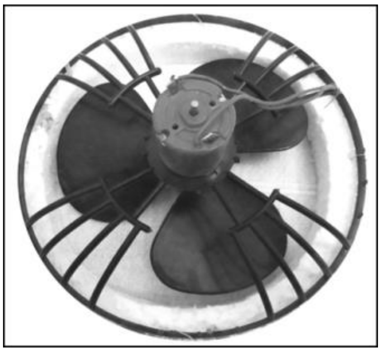

Fig. 5. The fan

Transmission of Information by Radio Waves

FM radio waves uses frequency modulation that alter or modulate the signal frequency while maintaining constant amplitude. When the frequency is modulated, sound or information is transmitted through the carrier frequency [1].

The transmitter signal is first encoded using a modular format, either AM or FM. To save electronic circuits, the initial information is transformed into a radio frequency signal intermediate or IF. It is then converted to the frequency, is amplified and transmitted from the antenna to be received at further distances. At the receiver, it is adjusted to the proper frequency band in order to receive the signal. This is again converted to an intermediate radio signal and then this signal is demodulated according to the modulation used to encode the original information. Further on, it is amplified and then sent to the user as voice, music or other data [1].

For this project, the information transmitted by the remote electronic module consists in the user's commands taken by the levers.

Levers act two circuit breakers located on the remote control. These commands are encoded using frequency modulation and released into the air in the form of radio waves through the antenna.

The command and control module located on the mobile platform of the vehicle receives these radio waves containing encoded commands captured from the user in FM. The module then decodes the commands, an important role in the process of decoding starring integrated circuit MX 117. Remote transmits 35 MHz frequency band.

Conclusion

The main objective of this study was to present the construction and operation of an air-cushion vehicle and its control using radio waves. The presented model was built to illustrate the feasibility of achieving such a whole and does not serve a practical role. Uses of air-cushion vehicles are numerous after as presented in this project, but their use and small – scale construction is impracticable. In general small-scale vehicles are built to access small area or tight but air-cushion vehicles do not work well in these types of environments.

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Imagine de ansamblu asupra vehiculelor pe pernă de aer

Rezumat

Scopul acestei lucrări a fost de a prezenta o imagine de ansamblu asupra vehiculelor pe pernă de aer, precum şi construcţia unui astfel de vehicul şi controlul acestuia folosind undele radio. Modelul prezentat a fost construit pentru a ilustra fezabilitatea realizării unui astfel de ansamblu şi nu serveşte un rol practic . Modelul construit nu are capacităţi şi performanţe foarte bune , asemenea vehiculelor realizate la scara mare, datorită materialelor şi componentelor folosite. Performanţele pot fi însă, îmbunătăţite prin implementarea modelului la scară mai mare, având o forma mai elaborată.