ANDROID CONTROLLED HOVERCRAFT FOR SPACE MISSION

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***Abstract*- The most common problem of most of the hovercraft projects today is that it is not that efficient in taking turns with full power which makes them unsuitable for space missions. So this problem no longer exists now as we have introduced our 'High Performance Android Controlled Hovercraft for several space missions '.Hovercraft is a vehicle with no wheels but still capable of moving. This is made possible with the help of an air skirt 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 of motors which rotate at a very high RPM and thereby generates 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 an 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 and taking appropriate action.**

I. INTRODUCTION

A hovercraft is a device that moves by floating on a cushion of air. A hovercraft, also known as an air-cushion vehicle or ACV, is an amphibious craft capable of travelling over land, water, mud, ice, and other surfaces.

Hovercraft use blowers to produce a large volume of air below the hull, or air cushion, that is slightly above atmospheric pressure.The pressure difference between the higher pressure air below the hull and lower pressure ambient air above it produces lift, which causes the hull to float above the running surface. For stability reasons, the air is typically blown through slots or holes around the outside of a disk- or oval-shaped platform, giving most hovercraft a characteristic rounded-rectangle shape. Typically this cushion is contained within a flexible "skirt", which allows the vehicle to travel over small obstructions without damage.

Hovercraft are vehicles used for carrying people and heavy objects over water and rough surfaces. Powerful fans, like airplane propellers, blow air downward. The air blast is caught by a skirt that lifts the craft above the surface before the air escapes to the sides under the lower edges of the skirt. This reduces friction with whatever surface over which the craft is hovering and enables it to be easily propelled by action/reaction with other fans mounted horizontally.

If we have mixed feelings about friction, it's easy to understand. Friction is the force that resists motion when two objects are in contact with each other. It's both good and bad. Take cars, for example. Forget to check the oil, and friction can ruin a car engine. However, without friction a car couldn't move. Tires are made from rubber, which produces friction with the road surface. When the wheels turn, friction enables the wheels to exert a force on the road to propel the car.Reducing friction makes it easier to start objects moving. Isaac Newton's first law of motion explains why. The law states that objects remain still unless acted upon by unbalanced forces. In other words, if forces on an object are unbalanced, the object moves.

In space, friction is greatly reduced because of the microgravity environment. It feels like gravity has gone away. Of course, gravity is still there because gravity holds the ISS in orbit. But orbiting Earth is like a continuous fall where the spacecraft and everything inside falls together. The type of friction caused on each other is gone. To move, astronauts have to push (exert an unbalanced force) on something, and to stop themselves, they have to push on something else. NASA uses many different simulators to train astronauts. One simulator is something like a large air hockey table. It is called the Precision Air Bearing Platform (PABP) and is located at NASA Johnson Space Center in Houston, Texas. The PABP uses moving air to produce a powerful lifting force very much the way hovercraft work. High-pressure air rushes out of three small pad-like bearings and lifts the pads, and a platform mounted above them, a fraction of a centimeter from the floor. No longer resting directly on the floor, the device, with the astronaut on top, is virtually frictionless. A Lithuanian Coast Guard Griffon Hoverwork 2000TD hovercraft with engine off and skirt deflated (first image), and with engine on and skirt inflated The first practical design for hovercraft was derived from a British invention in the 1950s to 1960s. They are now used throughout the world as specialised transports in disaster relief, coastguard, military and survey applications, as well as for sport or passenger service. Very large versions have been used to transport hundreds of people and vehicles across the English Channel , whilst others have military applications used to transport tanks, soldiers and large equipment in hostile environments and terrain. Decline in public demand meant that as of 2018, the only public hovercraft service in the world still in operation serves between the Isle of Wight and South sea in the UK. Although now a generic term for the type of craft, the name *Hovercraft* itself was a trademark owned by Saunders-Roe (later British Hovercraft Corporation (BHC), then Westland , hence other manufacturers' use of alternative names todescribe the vehicles.

II. LITERATURE SURVEY

W. L. Sun and X. Gao et al. [1] The waypoint behavior is a method of trajectory tracking control for unmanned surface vehicles (USV). We take the waypoint behavior as the research object, choose speed, steering angle, capture radius, slip radius, lead distance, lead damper as features, and establish a prediction model for trajectory tracking control of USV based on deep neural networks. The model effectively predicts the navigation effect and provides assistance and reference for the maneuvering decision of the USV. Test results show that the predicted results and the reference samples have the same tendency. The proposed model can improve the performance of trajectory tracking control for the USV.

Huu Khoa Tran et al. [2] In this study, genetic algorithms, during a short operation period, were utilized to optimize the parameters of an autonomous hovercraft controller. The proposed method achieved good performances in terms of response (fast), stability (high), error (low), and overshoot (none at all). In addition, the improved GA methodology, which was implemented by making some simple changes inside the standard GA's process that neglects/eliminates the chromosome decode step, displayed better performances in convergence speed. Especially, the modified GA can update the error fitness function in a smaller number of generations. It is undeniable that the improved GA is valuable in the optimization processes, particularly in optimizing the controller parameters. In further research, the authors would like to enhance the efficiency of the modified GA by using another error criteria, such as: ITSE (integral of time weighted square error) and MSE (mean square error). The disturbances attack to system models will be also considered

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to verify the efficiency of the process of optimizing control disturbing parameters.

Wei Xie et al. [3] have addressed the tasks of trajectory tracking (TT) and path following (PF) for a hovercraft vehicle in the presence of uncertain parameters and unknown external disturbances. Building on the backstepping technique, the proposed TT (PF) control laws are able to drive a hovercraft toward and stay within a neighborhood of a reference trajectory (path), achieving global practical stability. Moreover, the devised control strategies also guarantee that the actuations remain bounded with respect to the position error.

Mingyu Fu et al. [4] have presented a finite-time PI trajectory tracking control strategy for hovercraft with drift angle constraint. The control strategy enhances the robustness of the closed-loop system with model uncertainty and external disturbance. Based on the 4-DOF model, the desired velocities are designed according to the finite-time theory, and the desired yaw angular velocity is designed according to the finite-time PI sliding mode method. The velocity tracking errors and yaw angular velocity errors are stabilized by the designed finite-time PI sliding mode controllers and all tracking errors can be guaranteed to converge to zero in finite time. Lei Qiao et al. [5] have focused on the design of an adaptive second-order fast nonsingular terminal sliding mode control (ASOFNTSMC) scheme for the trajectory tracking of fully actuated autonomous underwater vehicles (AUVs) in the presence of dynamic uncertainties and time-varying external disturbances. First, a second-order fast nonsingular terminal sliding mode (SOFNTSM) manifold is designed to achieve a faster convergence rate than the existing second-order nonsingular terminal sliding mode (SONTSM) manifold. Then, by using this SOFNTSM manifold, an ASOFNTSMC scheme is developed for the fully actuated AUVs to track the desired trajectory. The designed SOFNTSM manifold yields local exponential convergence of the position and attitude tracking errors to zero, and the developed ASOFNTSMC scheme ensures that the error trajectories always move toward the SOFNTSM manifold and once they hit the manifold, remain on it in the presence of dynamic uncertainties and time-varying external

Michael R. Benjamin et al. [6] have described a set of software modules and algorithms for obstacle avoidance. The approach described here is designed to work in conjunction with any path planning method that generates a viable sequence of waypoints, with obstacle avoidance regarded as a local deviation of the planned path of points. The helm architecture used here will temporarily spawn a new obstacle avoidance behavior for each near a detected obstacle, and generate a maneuvering objective function to avoid the obstacle. Once the vehicle passes the obstacle, the helm deletes the behavior and frees its memory space. The helm, obstacle manager, and obstacle avoidance behavior are described here. This software arrangement was used by the MIT 2014 RobotX team and will be included in the next software release of the open-source MOOS-IvP marine autonomy project.

III. METHODOLOGY

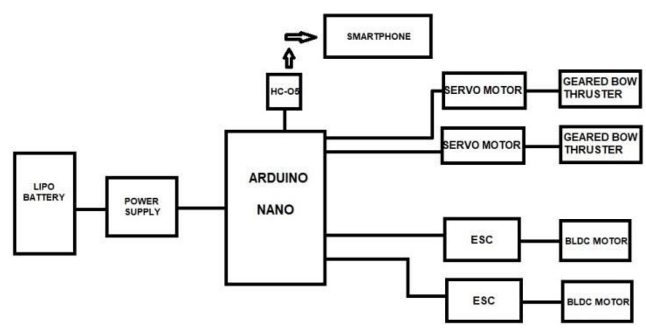

Fig 3.1 Block Diagram of Hovercraft

The system has two BLDC motors, one for pushing hovercraft forward, second one for filling up air below to lift it above the surface. The whole setup is controlled by microcontroller Arduino nano. The command to control the various movements like left right forward movements are sent by Smartphone APP to Bluetooth trans-receiver module HC-05 connected to Arduino nano.

In the forward part of the hovercraft there are two movable bow thrusters that push out air from below the lifted air bag to assist in movement of the hovercraft. The bow thrusters move left-right with vehicle turning, directing the air flow from

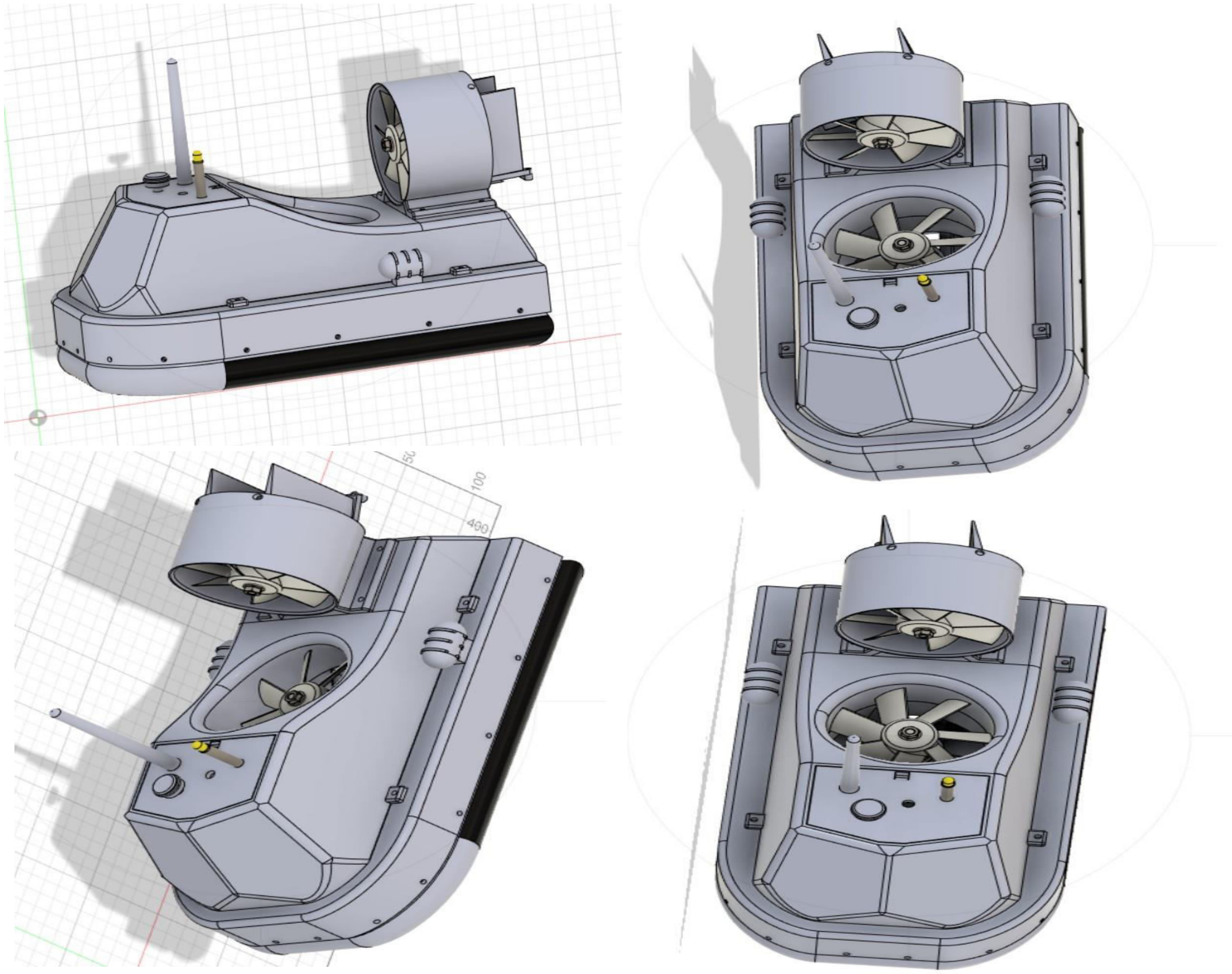

Fig 3.2: 3D Representation of a Hovercraft

thrusters in assisting vehicle movement, increasing efficiency of the hovercraft .

On the backside of HOVERCRAFT there is a pusher motor with propellers that help in achieving forward movement to the vehicle. To lift the hovercraft above surface there is a motor placed in the center of Hovercraft that takes air from surrounding inside with the help of a propeller to fill the air bag for lift hovercraft above surface for frictionless movement of the vehicle.

The Arduino nano microcontroller controls all the functioning of hovercraft. The BLDC motors speed is controlled by Esc (Electronic speed controller) which works PWM signal pulse which is sent to by Arduino nano, Flap movement is achieved by servo motor giving appropriate degree rotation of flaps by servo motors by signal from Arduino nano.

The Arduino nano is connected to HC 05 Bluetooth module which can be paired with any smartphone, the smartphone sends commands to HC 05 which send to Arduino nano, then Arduino nano gives appropriate function to hovercraft as specified in the command. The system is powered by a rechargeable Li-po (Lithium Polymer) battery. The principle of working of a Hovercraft is to lift the craft by a cushion of air to propel it using propellers. The idea of supporting the vehicle on a cushion of air developed from the idea to increase the speed of boats by feeding air beneath them.

The air beneath the hull would lubricate the surface and reduce the water drag on the boat and so increase its speed through water.The air sucked in through a port by large lifting fans which are fitted to the primary structure of the craft. They are powered by gas turbine or diesel engine. The air is pushed to the underside of the craft. On the way apportion of air from the lift fan is used to inflate the skirt and rest is ducted down under the craft to fill the area enclosed by the skirt.

At the point when the pressure equals the weight of the craft, the craft lifts up and air is escaped around the edges of the skirt. So a constant feed of air is needed to lift the craft and compensate for the losses. Thus craft is lifted up. After the propulsion is provided by the propellers mounted on the Hovercraft. The airs from the propellers are passed over rudders, which are used to steer the craft similar to an aircraft. Hovercraft is thus propelled and controlled and its powerful engine makes it fly.

IV. CONCLUSIONS

It can be used in any relatively flat surfaces where the skirt can seal, short grass, mud, sand, snow, ice water, concrete pretty much anywhere except loose rocks and long grass because the sport fields, lakes, rivers, dams etc. Travel over any surface and No collision with debris, logs etc.It requires a different amount of force and wing sizes of the propellor according to which planet mission have to be done.

Proper study of atmospheric pressure to force required of different space missions have to be done as every planet has different atmospheric pressure and gravity than that of earth.Significantly reduce the workload of land rovers in a space mission. Ensures almost immediate response to most situations. Provides a centralized means of transportation.Can be up-scaled to provide safety and escort services after embedding AI into it. Has a wide variety of outer space applications and military applications

VI. FUTURE SCOPE

This project report deals with specifying the proposed framework involved in the development of a semi-autonomous hovercraft aimed towards aiding for space missions.It illustrates the proposed methodologies and various other key aspects of developing a Semi-autonomous vehicle that can potentially be used for a wide variety of applications that include space missions, gathering outer space object data's and also in military applications.The methods and utilities proposed in this document outlines the procedures involved in the development of a Semi Autonomous hovercraft vehicle and mainly serves as a framework for the initial concept in abstract.

The main aim of this hovercraft project is to eliminate the use of standard robotic rovers which have the disadvantage of disrupting landing issues which leads to mission failure.

Hovercraft can launch and land anywhere, travel over almost any kind of surface, race along at high speeds, and efficiently carry large numbers of equipment or hefty military cargos ,heavy cameras, sensors, oxygen tanks for thrusters.

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