IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⋇ Peer-reviewed / Refereed journal ⋇ Vol. 11, Issue 12, December 2024

DOI: 10.17148/IARJSET.2024.111206

LITERATURE SURVEY ON TECHNOLOGY USED IN DESIGN OF AMPHIBIOUS HOVERCRAFT

Mr. Mithun C[1], Mr. Chintan D S[2], Mr.B S Bhargav[3], Dr. P N Sudha[4]

Electronics And Communications, K S Institute Of Technology, (Affiliated to VTU) Bengaluru, India[1-4]

Abstract: An amphibious hovercraft is a versatile vehicle designed to travel across both land and water, providing unparalleled mobility in challenging environments. By utilizing a cushion of air generated by large fans, it can glide over various surfaces, including water, mud, ice, and sand. This makes it ideal for operations in flood-prone areas, wetlands, and rough terrains where traditional vehicles might struggle. The hovercraft's ability to operate seamlessly between land and water enables rapid response in emergency situations, such as rescue missions and disaster relief. Additionally, its applications extend to military, transportation, and recreational uses. Despite its benefits, challenges like fuel efficiency, noise, and maintenance need to be addressed for widespread adoption. Modern amphibious hovercrafts are often equipped with advanced technologies such as GPS navigation, sophisticated propulsion systems, and durable materials to enhance performance and reliability.

Index Terms: Skirt Design, Hybrid Propulsion, Durable Materials.

I. INTRODUCTION

The skirt of an amphibious hovercraft is an essential component in the vehicle's operation. It is a flexible structure, typically made of rubberized fabric, that forms the boundary of the air cushion. The primary role of the skirt is to contain and direct the flow of air underneath the hovercraft, which allows the vehicle to float and move across various surfaces. Without the skirt, the air would disperse and the hovercraft would lose its ability to float.

In addition to creating the air cushion, the skirt helps stabilize the vehicle by preventing air from leaking and controlling the hovercraft's height. The design and construction of the skirt are vital factors in ensuring the performance and efficiency of the hovercraft, especially in amphibious applications. Skirt design influences several aspects of hovercraft operation, including lift, thrust, stability, durability, and maneuverability.

Types of Skirts

Hovercraft skirts come in various designs depending on the intended use of the hovercraft. Some skirts are designed for specific environments, while others are more versatile, suitable for a range of terrains. The two main types of skirts are:

1. Rigid Skirts: These skirts have a solid structure and are generally used for heavier-duty hovercrafts. Rigid skirts can provide greater support for large hovercrafts and are typically used in military or commercial applications where more stability and durability are required.

2. Flexible Skirts: Most modern hovercrafts use flexible skirts, which are more adaptable and better suited for lighter vehicles. These skirts are made of multiple segments, allowing for a greater range of movement and easier adjustments to varying terrain. Flexible skirts are commonly used for smaller, recreational, and amphibious vehicles, as they offer a balance of lightweight design and functionality.

1. Material Selection: The skirt material must be durable, lightweight, and flexible enough to withstand varying pressures and forces from different surfaces. The most commonly used materials include rubberized fabrics, reinforced nylon, and polyester. These materials ensure that the skirt can handle the stresses of lift generation, movement, and the abrasions of contact with surfaces.

2. Shape and Configuration: The shape of the skirt is crucial for efficient air containment. Skirts can be designed with different shapes such as flared or tapered, each providing distinct advantages in terms of stability and lift. Additionally, skirts are often segmented into sections (called "flaps"), which help adjust to surface contours, providing more controlled lift and smoother movement.

DOI: 10.17148/IARJSET.2024.111206

3. Skirt Height and Flexibility: The height of the skirt should be tailored to the specific design of the hovercraft, as it influences both the hovercraft's clearance above the surface and the amount of air required for hover. Skirts are often designed to be flexible so they can easily adjust to different terrains, such as uneven ground or waves on water. Flexibility allows for a more efficient distribution of the air cushion, enhancing performance.

4. Air Flow Management: The skirt design must ensure that air is evenly distributed under the hovercraft to provide uniform lift. The air cushion's stability is maintained by adjusting the skirt's shape and structure to minimize air loss and to enhance lift. The number of segments, the material properties, and the overall design all play a role in ensuring proper air flow.

The Science of Lift and Thrust in Skirt Design

Hovercrafts rely on the principle of air cushion technology to stay afloat. A fan or blower produces high-pressure air, which is forced underneath the hovercraft through vents in the skirt. This air creates a cushion that lifts the hovercraft off the surface. The skirt ensures that the air remains trapped underneath the craft, reducing friction and allowing it to glide over surfaces with minimal resistance.

The lift generated by the skirt depends on several factors, including the volume of air pumped into the air cushion and the seal efficiency of the skirt. Thrust is typically generated by separate engines or fans that propel the hovercraft forward, and the skirt's design influences the hovercraft's ability to maintain balance between lift and thrust. In amphibious hovercrafts, skirts are designed to provide sufficient lift on both water and land surfaces. While the hovercraft might generate more lift in water due to its buoyant properties, land surfaces require the skirt to be more flexible and adapt to the changing pressures exerted by the terrain.

Challenges and Innovations in Skirt Design Over time, significant innovations in skirt design have made hovercrafts more efficient and capable. Modern hovercrafts often feature more complex and adaptive skirt systems that allow them to better navigate through changing environments. The integration of smart materials, such as those that change shape or stiffness in response to environmental conditions, is one example of how skirt technology is evolving.

However, challenges remain in creating skirts that balance efficiency with durability, especially in the face of demanding operating environments. For instance, a skirt that works well on water may not perform as effectively on land, requiring further design modifications

II. LITERATURE REVIEW

The amphibious hovercraft is a fascinating vehicle, with applications across a wide range of industries, from military and search and rescue to environmental monitoring and transportation. As the demand for vehicles capable of traversing various terrains has increased, hovercraft technology, particularly the skirt design, has seen significant research and development. This literature survey highlights key studies, advancements, and technological innovations in the field of hovercrafts, with a special focus on skirt design and its impact on performance, stability, and maneuverability.

The skirt design is critical to the overall performance of the hovercraft, particularly in terms of its ability to maintain lift, stability, and maneuverability across diverse terrains. Initial skirt designs were rudimentary, typically composed of fabric materials that had limited durability and flexibility. As hovercrafts became more widespread, research focused on optimizing skirt materials and designs to achieve greater stability and performance.

The research paper by Jesús Mena-Oreja and Javier [1], titled "On the Impact of Floating Car Data (FCD) and Data Fusion on the Prediction of Traffic Density", explores the use of Floating Car Data (FCD) and data fusion techniques to improve traffic density predictions. The authors focus on the process of data fusion, where information from multiple sensors and sources is integrated to provide more accurate traffic density predictions. The study also evaluates the effectiveness of machine learning algorithms and statistical methods for processing and analyzing this data. The findings demonstrate that the fusion of FCD with other data sources can significantly improve prediction accuracy.

The study by Yao Yao et al [2] , examines the impact of rainfall on urban traffic congestion using geospatial data, floating car data (FCD), and GIS tools. Focusing on Shenzhen, China, the researchers developed an Index Calculation and Clustering (ICC) model, incorporating PageRank and clustering algorithms, to analyze congestion changes. Findings reveal that rainfall reduces weekday road speeds by 6.2% and weekend speeds by 2.37%, while congestion areas expand significantly. The ICC model offers deeper insights than traditional methods, aiding policymakers in devising better traffic management strategies.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⪫ Peer-reviewed / Refereed journal ⪫ Vol. 11, Issue 12, December 2024

DOI: 10.17148/IARJSET.2024.111206

The research by Yongfa Li, Xiaoqing Zuo, and Fang Yang[3] investigates urban resident activity patterns and hotspot areas by leveraging GPS floating car data. The study focuses on preprocessing and analyzing large datasets to extract passenger pick-up points and travel trajectories, enabling a detailed understanding of movement patterns in urban environments. This paper’s findings aim to support urban planning, optimize public transportation systems, and improve traffic management strategies. This study highlights the role of geospatial analysis in addressing urbanization challenges and enhancing city infrastructure planning.

The study by Ebrahim H. H. Al-Qadami[4] and colleagues investigates the floating stability of vehicles under partial submergence in flood conditions using scaled-down model tests and numerical simulations. The research examines critical parameters like water depth, vehicle orientation, hydrodynamic forces (drag, buoyancy, and lift), and vehicle features such as weight and ground clearance. Factors like flow velocity, depth, and vehicle orientation significantly influence stability. A 90- degree orientation (vehicle side facing the flow) proved the most critical for stability.

The study provides insights for flood safety measures, highlighting the need for vehicle design improvements and infrastructure planning to mitigate risks during floods.

The study by Jörg Firnkorn and Martin Müller[5] evaluates the environmental effects of free-floating car-sharing systems, focusing on CO2 emissions and potential shifts in urban transportation. Using the example of "car2go" in Ulm, Germany, the researchers developed a model to assess how these systems influence private car ownership, vehicle usage, and emission patterns. Outcomes of this paper suggest that car- sharing reduces private car dependency, potentially cutting CO2 emissions if vehicles are used efficiently and substitute less sustainable modes of transport. However, the environmental benefits depend on user behavior and operational practices.

The paper by A.K. Yakimov et al [6] explores the mechanical properties of skirt materials used in hovercraft under dynamic loading conditions. It involves experimental evaluations of various materials to determine their tensile strength, tear resistance, and elasticity. The tests simulate real-world operational stresses such as impact forces and repeated flexing, which are common during hovercraft operation. The findings contribute to optimizing material selection for durability and efficiency in hovercraft design, particularly under challenging conditions like rapid airbag inflation and terrain irregularities. This research is pivotal for enhancing hovercraft performance and operational reliability.

The study [7], have shown how power can be optimized in any communication system. Power optimization is providing optimum power to devices that is providing less power wherever less power is required and more power wherever maximum power is required.

The study by G. Chen et al[8] , examines the aerodynamic performance of hovercraft skirts using Computational Fluid Dynamics (CFD) simulations. The research analyze how different skirt designs impact airflow, pressure distribution, and lift generation during operation. Key parameters, such as skirt geometry and material behaviour, were evaluated to optimize hovercraft stability and efficiency. The results highlight the importance of tailored skirt designs to enhance aerodynamic performance, ensuring reduced drag and improved fuel efficiency. This research provides valuable insights for advancing hovercraft engineering and operational reliability.

The study by Y. Li et al[9] , investigates the impact of skirt design on the stability of hovercrafts operating in rough water conditions. Using experimental setups, the researchers evaluated the performance of various skirt geometries subjected to wave-induced forces. The focus was on assessing the dynamic response, stability, and deformation of skirts under simulated rough sea environments. The findings revealed that certain geometries better dissipate wave energy and reduce instability, enhancing the hovercraft's ability to maintain balance and operational integrity. This research is significant for improving hovercraft performance in challenging maritime conditions, especially for applications requiring consistent stability, such as rescue missions and military operations.

The study by M. Smith et al.[10] focuses on the fatigue behavior of hovercraft skirt materials under cyclic loading conditions. Using specialized fatigue testing machines, the research evaluates the durability and mechanical degradation of these materials when subjected to repetitive stress over time. The findings aim to identify optimal materials that offer superior longevity and performance under dynamic operational conditions. This work is critical for improving hovercraft reliability and minimizing maintenance costs, particularly in demanding environments.

The paper by R. Martinez et al.[11] investigates how temperature variations affect the material properties of hovercraft skirts. The study employs experimental methods to simulate varying environmental conditions and measures key

DOI: 10.17148/IARJSET.2024.111206

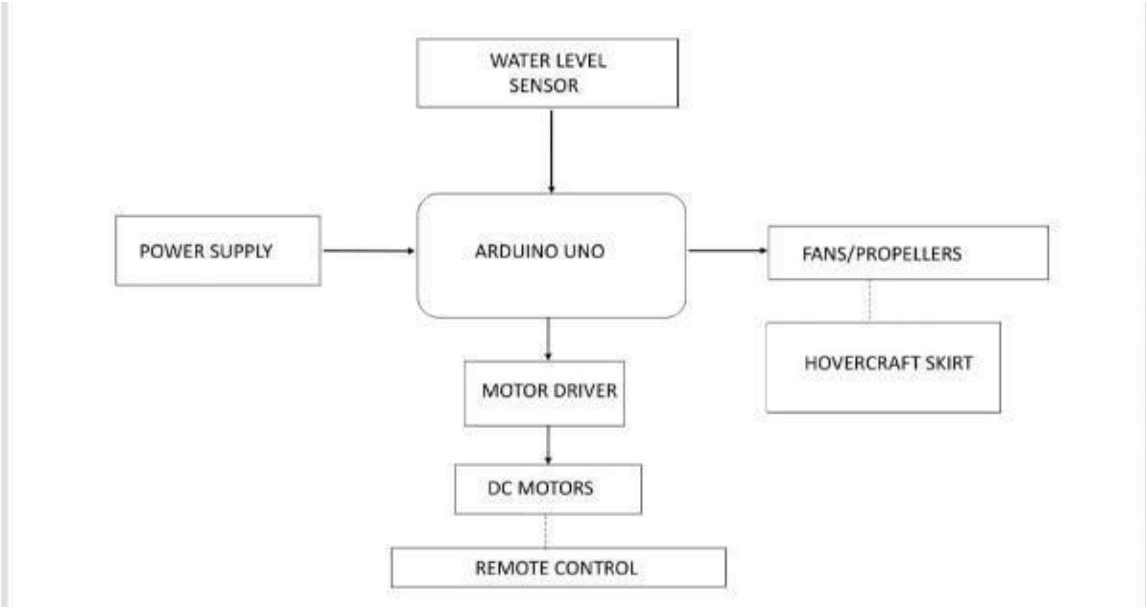
mechanical properties such as tensile strength, elasticity, and durability. Results indicate that temperature changes significantly influence the performance and longevity of the skirts, particularly in extreme conditions, leading to material degradation or reduced flexibility. These findings are critical for hovercraft design, ensuring materials are chosen to withstand diverse operational environments while maintaining safety and performance.

In this, authors [12] "Development of a New Hovercraft Skirt for Enhanced Performance," focuses on designing and simulating an advanced skirt structure to improve hovercraft functionality. Using computational modeling techniques, the research aimed to optimize the geometry and material composition of the skirt.

The novel design integrates enhanced air cushion containment and flexibility, addressing common challenges such as wear, tear, and maintenance frequency. The results of the simulations and initial tests demonstrated improved load distribution and stability during operation, reducing material stress and increasing the lifespan of the hovercraft's skirt system

III. PROPOSED METHOD

Block Diagram



Brief explanation

The methodology for the amphibious hovercraft project begins with identifying key problems such as environmental adaptability, material limitations, and challenges in transitioning between land and water. These issues impact the performance, durability, and functionality of the hovercraft. To address these challenges, objectives were defined: selecting durable materials capable of withstanding dynamic loading, designing an efficient and adaptable skirt system to enhance stability, and developing hybrid propulsion and lift systems to ensure smooth transitions across terrains.

The system design incorporates components like an Arduino board for control, DC motors for propulsion, motor drivers for speed and direction control, fans or propellers for lift, and a flexible hovercraft skirt to maintain an air cushion. The methodology concludes with building the system, testing its performance under varying conditions, and analyzing results to refine the design and achieve project goals.

Expected outcomes

The expected output of the amphibious hovercraft project is a functional vehicle capable of smooth operation on both land and water, with seamless transitions between the two terrains. The hovercraft will exhibit stability during operation, supported by an efficient skirt design that adapts to varying environmental conditions.

DOI: 10.17148/IARJSET.2024.111206

IV. CONCLUSION

The possible outcomes for the proposed scheme are:

- Material selection is critical to ensure the durability of components exposed to dynamic loading and harsh environmental conditions. It is essential to identify and rigorously test materials that can withstand these challenging factors, as demonstrated in previous studies on material resilience under varied operational stresses.

- An efficient skirt design is crucial for improving the stability and adaptability of hovercrafts across various terrains. Recent studies emphasize the need for innovative skirt geometries that can provide optimal load distribution and cushion pressure control, ensuring better maneuverability and stability in diverse environmental conditions.

- To enhance terrain adaptability, the development of a hybrid propulsion and lift system is essential for ensuring dynamic adjustments across different surfaces, such as land and water. Recent studies have shown that optimizing thrust and lift mechanisms can improve stability, facilitate smooth transitions between terrains, and increase operational efficiency.

REFERENCES

[1]. Mena-Oreja, J., & Gozalvez, J.”On the impact of floating car data and data fusion on the prediction of traffic density”. IEEE Access, 9, 133710–133724.DOI 10.1109/ACCESS.2021.3096720. (2021)
[2]. Yao Yao et al, “Analyzing the Effects of Rainfall on Urban Traffic-Congestion Bottlenecks”, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (IEEE JSTARS) in 2020.
[3]. Yongfa Li, Xiao Qing Zuo, And Fang Yang “Research on Urban Resident Activity Patterns and Hotspot Area Based on GPS Floating Car Data” , was published in IEEE Access, Volume 12 10.1109/ACCESS.2019.2962536.(2023)
[4]. Ebrahim H. H. Al-Qadami et al. Numerical assessment on floating stability limits for static vehicleunder partial submergence Journal of Engineering Science and Technology. It appears in Volume 15, Issue 2, April 2020, and span pages1387-1390 (2022).
[5]. Jörg Firnkorn and Martin Müller "What will be the environmental effects of new free-floating car- sharing systems? The case of car2go in Ulm" Ecological Economics. It appears in Volume 70, Issue 8, spanning pages 1519–1528. (2021)
[6]. A.K. Yakimov et al.” Analysis of Skirt Material Properties for Hovercraft Under Dynamic Loading Conditions” , journal Solid State Phenomena (2023).
[7]. B Devika ,PN Sudha “Power Optimization in MANET using Topology Management” published in Engineering Science and Technology, an International Journal, ISSN 22150986, ELSEVIER BV, July (2020)
[8]. G. Chen et al. “Numerical Study on the Aerodynamic Performance of Hovercraft Skirts” appears in The Aeronautical Journal, published by Cambridge University Press.(2022).
[9]. Y. Li et al. “Impact of Skirt Design on Hovercraft Stability in Rough Water Conditions” published in Anveshana's International Journal of Research in Engineering and Applied Sciences (AIJREAS).
[10]. M. Smith et al. “Investigation of Material Fatigue in Hovercraft Skirts” published in Solid State Phenomena, Volume 265, spanning pages 615-619 (2024).
[11]. R. Martinez et al. “Effects of Temperature Variations on Hovercraft Skirt Material Properties” published in the journal Solid State Phenomena, Volume 265, on pages 615-619 (2021).
[12]. H. Liu et al “Development of a New Hovercraft Skirt for Enhanced Performance” is from Volume 1, Issue 11 (2023).