

PERPUSTAKAAN UMP



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A MODEL WORKING HOVERCRAFT

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ABSTRACT

The purpose of this study is to design and investigate of a mini working hovercraft which providing fully hovercraft basic function. This final year project carry out by the author to fulfilment the requirement for award the degree of Bachelor Mechatronic Engineering. For PSM 1 is to design the several model of hovercraft and for PSM 2 is to implement the design to the real mini working hovercraft. Basically, the hovercraft design and fabrication process is a quite similar to boat, ship, or aircraft design. By implement this project as a type of applying the knowledge and all theory especially for mathematical and scientifically as well. In this report, I had made the entire analysis requirement, formulas for thrust and lift, drag component calculation and other important parameters to realization the design of the working hovercraft. For the electrical part also has mention in this report that describe all the component and connection for the system of hovercraft. On the other hand, this report is aim to provided objective and scope of the research, the literature review, research methodology, and fabrication process with result analysis and conclusion as part of requirement in submitted the report to PSM supervisor. Although hovercraft research and development is still new technology in Malaysia and no domestic consumption in this technology, but through this project it can help the industry a step further. It is because this project can categorized as successful and working as expected. Finally, I wish this project can carry on research and design development by interest mechatronic student.

ABSTRAK

Tujuan kajian ini adalah untuk mereka bentuk dan mengkaji tentang model hoverkraf yang mempunyai sepenuhnya fungsi asas hoverkraf. Projek tahun akhir yang dijalankan ialah untuk memenuhi keperluan anugerah ijazah Sarjana Muda Kejuruteraan Mekanik. Untuk PSM 1 adalah untuk mereka bentuk beberapa model hoverkraf dan PSM 2 adalah untuk melaksanakan reka bentuk serta menjalankan kajian analisis. Pada asasnya, reka bentuk dan fabrikasi proses hoverkraf adalah agak sama dengan bot, kapal, atau reka bentuk pesawat. Dengan melaksanakan projek ini dapat mengaplikasikan serta menggunakan pengetahuan dan semua teori terutama matematik dan saintifik. Dalam laporan ini, saya telah membuat analisis keperluan keseluruhan, formula untuk teras dan apungan, mengheret pengiraan komponen dan parameter lain yang penting untuk merealisasikan reka bentuk hoverkraf. Untuk bahagian elektrik juga telah disertakan dalam laporan ini yang menerangkan semua komponen dan sambungan bagi sistem hoverkraf. Sebaliknya, laporan ini adalah bertujuan untuk memenuhi semua objektif dan skop penyelidikan, kajian literatur, kaedah penyelidikan, dan proses fabrikasi dengan analisis keputusan dan kesimpulan sebagai sebahagian daripada keperluan dalam mengemukakan laporan kepada penyelia PSM. Walaupun kajian hoverkraf dan pembangunan masih teknologi baru di Malaysia dan tiada penggunaan domestik dalam teknologi ini, tetapi melalui projek ini, ia boleh membantu industri seterusnya. Ia adalah kerana projek ini boleh dikategorikan sebagai kejayaan dan boleh berfungsi seperti yang dijangkakan. Akhir sekali, saya berharap projek ini boleh dijadikan penyelidikan dan reka bentuk oleh pelajar mekatronik yang berminat.

TABLE OF CONTENTS

	Page
SUPERVISOR’S DECLARATION	ii
STUDENT’S DECLARATION	iii
DEDICATION	iv
ACKNOWLEDGEMENTS	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
LIST OF GRAPH	xiv
LIST OF SYMBOLS	xv
LIST OF ABBREVIATIONS	xx
CHAPTER 1 INTRODUCTION	1
1.1 Background Information	1
1.2 Problem Statement	2
1.3 Research Objectives	2
1.4 Research Scope	3
1.5 Research Question	3
1.6 Definition of Terms For Hovercraft	3
1.7 Expected Outcomes	4
1.8 Significance of Project	4
CHAPTER 2 LITERATURE REVIEW	6

2.1	Introduction	6
2.2	Background Information Of Hovercraft	6
2.3	Hovercraft Attention In Malaysia	8
2.4	Category Of Hovercraft	8
	2.4.1 Amphibious Hovercraft	8
	2.4.2 Non- Amphibious Hovercraft	8
	2.4.3 Semi-amphibious hovercraft	9
2.5	Material Of Manufacturing For Hovercraft	9
2.6	Design Consideration Of Hovercraft	9
	2.6.1 Design Consideration	11
	2.6.2 Design Criteria	11
	2.6.3 Principle Of Plenum Chamber	13
	2.6.4 Principle Momentum Curtain	13
2.7	System Of Hovercraft	13
	2.7.1 Lift system	13
	2.7.1.1 Lift System Calculation	14
	2.7.1.2 Lift Fan Calculation	14
	2.7.2 Thrust System	15
2.8	Hovercraft Dynamics	15
2.9	Advantages And Limitation	15
2.10	Application Of Hovercraft	17
CHAPTER 3 METHODOLOGY		19
3.1	Introduction	19
3.2	Research Methodology Flow Chart	20
3.3	Process Methodology Flow Chart	21
3.4	Making Of Hovercraft	22
	3.4.1 Shape Of Hovercraft	22

	Calculation Of The Loading Force Exerted On	
3.4.2	Hovercraft	23
3.4.3	Center Of Pressure And Balance	23
3.4.4	Center Of Gravity	23
3.5	Mechanical Design And Structure.	23
3.5.1	Mechanical Design And Planning	23
3.5.2	Mechanical Parts And Specification	24
3.5.3	Foam Board	24
3.5.4	Propellers For Lift And Thrust System	25
3.5.5	Structural And Layout	26
3.6	Electrical Design And Structure	27
3.6.1	Block Diagram	27
3.6.2	Circuit Diagram Of Arduino For Hovercraft	29
3.7	Lifting And Thrust System Electronic Connection	31
3.8	Play Station 2 Controller	32
CHAPTER 4	RESULT AND DISCUSSION	33
4.1	Introduction	33
4.2	Development Of Mechanical Design	34
4.2.1	Hovercraft Mechanical Design	35
4.2.2	Hovercraft Mechanical Part Implementation	36
4.2.3	Process Of Hovering Test	37
4.3	Development Of Electrical Part	39
4.3.1	Flow Of Electrical Part	39
4.3.2	Arduino Uno Pin Connection	40
4.3.3	Hovercraft Data Log	41
4.3.3.1	Hovercraft Performance Result With Tile Floor	42

	Hovercraft Performance Result With On	
4.3.3.2	Water	44
4.3.3.3	Hovercraft Performance Result With Cement Surface	46
4.3.3.4	Hovercraft Performance Result With Grass	48
4.4	Discussion	50
CHAPTER 5	CONCLUSION AND RECOMMENDATION	52
5.1	Conclusion.	52
5.2	Recommendation.	54
	REFERENCES	55
	APPENDICES	
A	Mechanical Construction	57
B	Electrical Construction	60
C	Arduino Programming	61
D	Component Specification	63
E	Bill Of Material	66
F	Play Station 2 Controller Manual	67

LIST OF TABLES

Table No.		Page
2.1	Basic parts of working hovercraft	7
2.2	Design consideration and Description	11
2.3	Design criteria and Description	12
2.4	Advantages and Description of Hovercraft	16
2.5	Disadvantages and Description of Hovercraft	17
2.6	Application of hovercraft	18
3.1	Shape type and Description	22
3.2	Mechanical Specification	24
3.3	Characteristics and Description of Propeller	25
3.4	The information of Arduino Uno	30
4.1	Label and Description of Mechanical Design	35
4.2	Label and Description Model of Hovercraft	36
4.3	Dimension of Model Hovercraft	38
4.4	Analysis of Hovercraft	38
4.5	Component Part and Pin Number in Arduino Uno	40
4.6	Hovercraft Performance Result with Tile Floor	42
4.7	Hovercraft Performance Result with on Water	44
4.8	Hovercraft Performance Result with Cement Surface	46
4.9	Hovercraft Performance Result with Grass	48
4.10	Performance of Hovercraft in Multi-floor Condition	50

LIST OF FIGURES

Figure No.		Page
2.1	Basic model of working hovercraft	7
3.1	Research Methodology Flow Chart	20
3.2	Process Methodology Flow Chart	21
3.3	Propeller	25
3.4	Structural part of Hovercraft	26
3.5	Multi-view of Hovercraft	27
3.6	Block Diagram of Arduino Uno for Hovercraft	28
3.7	Circuit Diagram of Arduino for Hovercraft	29
3.8	Real Circuit of Arduino Uno	30
3.9	Play Station Controller	32
4.1	Flow Chart Development of Mechanical Design	34
4.2	Multi-view of Hovercraft Design	35
4.3	Model of hovercraft	36
4.4	Process of Hovering Test	37
4.5	Flow Chart Development of Electrical Part	39
4.6	Arduino Uno Pin Connection	40
D1	ESC 25 A	
D2	AXN-2208-2150 Brushless Motor	
D3	Digital Servo Motor	
F1	PS 2 Controller Manual	

LIST OF GRAPH

Graph No		Page
4.1	Hovercraft Performance with Tile Floor	43
4.2	Hovercraft Performance with Water	45
4.3	Hovercraft Performance with Cement Surface	47
4.4	Hovercraft Performance with Grass	49
4.5	Hovercraft Performance with Multi-floor Condition	51

LIST OF SYMBOLS

F	Force
h	Clearance between the ground to the bottom of skirt
A	Area
ρ	Density
\dot{m}	Mass flow rate
π	pi
Q	The volumetric flow rate
D	Diameter
L	Length
W	Width

LIST OF ABBREVIATIONS

PWM	Pulse Width Modulation
RPM	Rotation Per Minute
CATIA	Computer Aided Three-dimensional Iterative Application
ESC	Electronic Speed Controller
PS 2	Play Station 2
V	Voltage
A	Ampere
I	Current
W	Watt
Pa	Pascal

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND INFORMATION

At the beginning of the history of hovercraft was created for apply use in military on 1915, however was mostly work on water. Meanwhile, in 1930 the principles and concepts of the airplane was merging by the inventors to their designs to develop the first vehicles that could hover over the land.

In this era of globalization, hovercraft is one of the vehicles that fly above the earth and it has a lot of function. There are several function of hovercraft that used for transportation, travelling, agricultural spraying, forestry, sport activities, recreational and so on. In fact, the other term of name of hovercraft is air cushion vehicle (ACV). Accordingly to the datum or fact of the ACV, it could provide high speed compared to the other marine vehicles and having excellent performance on rough surfaces as well. In the simplest word, a hovercraft is make the hull where it can float in water surface and by flexible skirt the air is remain that can carried on a cushion.

For the system of the hovercraft, it need at least two engines to ensure the hovercraft could function and working well. While, same goes to the mini prototype of hovercraft also needs two engines as well that the engines part is replace by the motor that decided by the designer. Actually, there are some reasons why hovercrafts use two engines in the same time that the first engine at the middle of body is use for lifting or floating.

The position of the engine is actually according to the designer decision. Hence, for the second engine is usually at the back side of the hovercraft for forward and reverse thrust.

For the concept of the hovercraft, the lifting or hover motor is function to produce and pushes the air out from bottom in order builds a pocket where to consist a higher pressure to trapped and raise. So, this theory is the evidence how the hovercraft could lifting and floating. The implication of the higher pressure escapes from the bottom part of hovercraft will produce the hovering effect. Although, several of hovercraft merely use one motor or engine for working on lifting and thrust but the brilliant require is use two or more engines.

1.2 PROBLEM STATEMENT

As a university student, I would like to execute a project regarding to apply, improve or understanding of the scientific principles toward the using of air flow concepts in order to lifting and moving process by using mini hovercraft.

1.3 RESEARCH OBJECTIVES

- 1.3.1 To design a mini working hovercraft prototype.
- 1.3.2 To implement a mini hovercraft that powered by two brushless motor for lifting and propulsion.
- 1.3.3 To apply and improve the scientific principles using air flow regarding hovercraft.
- 1.3.4 To run experiment, collect and verify the data specimen.

1.4 RESEARCH SCOPE

This study are focuses on six project scope.

- 1.4.1 To investigate how the air flow work in order to lifting (floating) and moving the hovercraft.
- 1.4.2 This study to determine the hovercraft could go travel over different surfaces more easily.
- 1.4.3 To find drag component and lift force that stride to hovercraft.
- 1.4.4 To find the design fundamental for mini working hovercraft.
- 1.4.5 To find the best material in order to build mini hovercraft.
- 1.4.6 To study the control mechanism hovercraft.

1.5 RESEARCH QUESTION

- 1.5.2 What is the system in controlling the hovercraft?
- 1.5.3 Which motor works best for hovering and thrusting?
- 1.5.4 Which propeller provides the greatest thrust?
- 1.5.5 What kind of power source gives the best performance?
- 1.5.6 Which propeller provides the greatest thrust?

1.6 DEFINITION OF TERMS FOR HOVERCRAFT

- 1.6.2 Hovercraft- Hovercraft is vehicle that hover or float over the ground. Air cushion vehicle(ACV) is the other name for hovercraft .The main system that to make the hovercraft working well are lift and thrust system. Both of these systems are support by the engine.
- 1.6.3 Skirt- Generally, the material made for skirt is water proof that to ensure the hovercraft can be able to float and hover over the ground. It is also grants air cushion to be maintained.
- 1.6.4 Lift- Lift is the air cushion beneath the hull surrounded by the skirt.

- 1.6.5 Thrust- Thrust is the force that will fight and win drag, inducing movement to the hovercraft.

1.7 EXPECTED OUTCOMES

Give the hovercraft the significance and quality of data information. After the prototype of mini hovercraft is being implemented, all of the knowledge could be apply and will enhance or understanding of the scientific principles involved in using airflow to both lift an object off from the ground surface including thrust process. So, by using mini hovercraft will give the outcomes or evidence in order to achieve all of the objectives.

1.8 SIGNIFICANCE OF PROJECT

After this project has been done, all of the knowledge could be apply either in scientifically or mathematically. In addition, when something knowledge that most of us have then apply into several application it would give us a lot of good implications such as to create a self-confidence .Other than that, by invention may give a lots of attraction to ourselves compared just learning the theoretical of some knowledge. Hence, it also creates our mind to think positively and become more creative. There are several principle that important on this project:

- 1.8.1 Bernoulli's principle
- 1.8.2 Momentum Curtain theory
- 1.8.3 Buoyancy Principle

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is to explain and describe about the literature review research for final year project on journal and the internet sources. This chapter also includes the findings and previous studies regarding to this project title will be presented. From the findings, the general information about the project can be gathered more easily before implement the experiment. Hence, this chapter also explains about the general review of the overall project.

2.2 BACKGROUND INFORMATION OF HOVERCRAFT

A hovercraft is a vehicle that is hovering just above the ground or over snow or water by a cushion of air (Razak, 2000). Other term of hovercraft is (ACV) or as known as air cushion vehicle. In a hovercraft a similar cushion of air is maintained by pumping in a steady supply air, to keep pace with the linkage round the sides. There is always some leakage because the craft has to be free to move, but the designers use various methods to keep leakage as small as possible so that only minimum power is required to keep up the air supply (James M. Pruett, 2001). There are various ways of creating of air cushion and reducing leakage. When the fan is rotated, the air pressure is push inside the skirt to create lifting and the hovercraft also has little to no friction and does not touch the ground. A hovercraft has been a public transportation in Europe since 1960's. (Malcolm W. Cagle,

1970). A well designed hovercraft is superior to a 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 above twice the fuel mileage of a boat with similar size or capacity (Liang Yun & Alan Bliault, 2000). 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 (Mujtaba Hussain, 2002). By using the concept and equation of Bernoulli, the volumetric flow rate of a hovercraft fan can be obtain. It is important in order the vehicle to hover based on its dimension and it's mass.

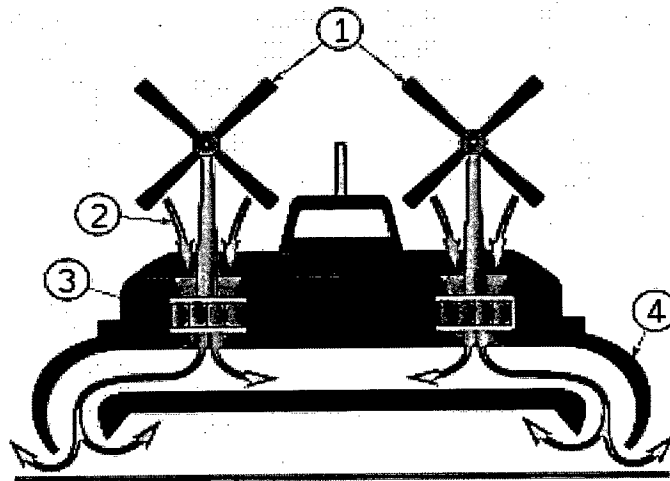


Figure 2.1: Basic model of working hovercraft

Table 2.1: Basic parts of working hovercraft

No	Name part
1	Propellers
2	Air
3	Fan
4	Skirt

2.3 HOVERCRAFT ATTENTION IN MALAYSIA

Hovercraft is getting attention in Malaysia. One of the major purposes of its introduction in Malaysia is to assist Fire and Rescue Department. This first hovercraft is produced by AFE manufacturing company with Japanese technology collaboration (NST, Malaysia 2003). The launching of the hovercraft in Putrajaya in 2003 has paved way for new opportunity in Malaysia manufacturing sector. This event is as a starter to be prepared for an event in 2006 where Malaysia will host World Hovercraft Championship (NST, Malaysia 2002-2006).

2.4 CATEGORY OF HOVERCRAFT

In the era of globalization, the hovercraft has been made in variety of shapes, sizes and types based on its characteristics and purpose. There are three main types or categories of hovercraft which are amphibious hovercraft, non-amphibious and the last one is semi-amphibious hovercraft.

2.4.1 Amphibious Hovercraft

Amphibious hovercraft are confined to off the road or over water surface operation because of their size and relatively poor manoeuvrability characteristics, which make the unstable to be mixed with conventional land vehicles (M. A. Chungtai, 2002).

2.4.2 Non- Amphibious Hovercraft

The non – amphibious hovercraft is limited to over water operation only. This type of hovercraft constructed whereby the air cushion or captured air bubble is contained beneath the craft by rigid side walls and flexible skirt at the front and rear of the craft that known as sidewall hovercraft.

2.4.3 Semi- Amphibious Hovercraft

Semi-amphibious hovercraft is also limited to travelling over water. It lies somewhere between fully amphibious and the non-amphibious sidewall types in principle of operating and use.

2.5 MATERIAL OF MANUFACTURING FOR HOVERCRAFT

Material uses for hovercraft hulls are high strength marine aluminum alloys, fabric-covered structures and fiberglass. High strength steels may be more attractive for larger craft (Winkler, P.J 2000).It also usually constructed from fiberglass, aluminum, plastic or plywood, or a combination thereof. It is necessary that a allocation for buoyancy so the craft will be able to float on water surface.

Skirt material for hovercraft based on nylon fabrics coated with Neoprene or natural rubber. The skirt is very the most important part of hovercraft due to it allows the hovercraft to clear obstacles. So, when the higher skirt, the larger the obstacles that the hovercraft will clear. The following was the consideration required during select of skirt materials (Liang Yun & Alan Bliault, 2000)

- a) Flexibility and anti-ageing capability of skirt cloth (nylon fabric coating)
- b) Tearing strength of material
- c) Tension strength of material

2.6 DESIGN CONSIDERATION OF HOVERCRAFT

The weight of the hovercraft is one of the considerations in design. Light- weight materials used for construction have the good strength for design. Moreover, the pressure design must in plenum chamber in order to create the sufficient lift force to the hovercraft (H. Emdad, 2007). Lift force is calculated by pressure time area of the craft. The lift force must more than the weight of the craft. On the other hand, moments are the consideration

for stability of the hovercraft. As rotating parts involved, the unbalanced moments particularly due to the lift fan must be balanced to avoid spinning of hovercraft (Dr.J.M Chuang, 2001). To generate the thrust force, a good power system must be design. The power supply to thrust is also one of the considerations. A bag skirt is generally preferred as it is easy to build and gives good performance of hovercraft. Duct system is also one of the mini design (R. Rathore, 2005). The duct although do not have much effect on thrust due to propellers. But, it must be design used for safety of propeller blades in design a duct should have a decreasing area towards exit, such that velocity of air, leaving the duct increases and hence thrust increases. Skirt is the other vital component or the common skirt is known as bag skirt. The skirt is purpose to cover the bottom of the craft that has a hole in it to allow air can be escape and push the craft off the ground. Unfortunately, the more stable of the skirt provide slow the movement of the craft.

2.6.1 Design Consideration

Before start designing the model hovercraft, there are several consideration need to be care. The main consideration is divided into four criteria which are economic concerns, manufacturability, performance and the last is serviceability. (Cean Williard, 2008)

Table 2.2: Design consideration and Description

No.	Consideration	Description
1	Economic	<ul style="list-style-type: none"> • The cost must be minimize
2	Manufacturability	<ul style="list-style-type: none"> • The manufacture must be constructed with limited resources and high efficiency
3	Performance	<ul style="list-style-type: none"> • The high performance is necessary in order to make the working hovercraft be able to lift and thrust.
4	Serviceability	<ul style="list-style-type: none"> • The serviceability is important because must be easy to maintain by the designer

2.6.2 Design Criteria

There are some of the criteria that should be care in designation of hovercraft especially for the four main parts which are for lifting process, thrust process, control and the materials as well. The table will show all of the criteria:

Table 2.3: Design criteria and Description

Criteria	Description
Lift	<ul style="list-style-type: none"> • The lift skirt is very essential due to generate air cushion for hovering. • The high performance of lift process is important because it must lift entire craft. • The propellers for lift must be appropriate because in order to provides the greatest lift. • The type of motor also needs to be care because the suitable motor can works best for hovering.
Thrust	<ul style="list-style-type: none"> • The propeller speed control is essential because it must has speed control for craft. • The type of motor chosen also is the thing that should be care in order to makes entire craft move greatest. • The chosen of propeller for thrust need to consider to provides the greatest thrust.
Control	<ul style="list-style-type: none"> • Control by remote that program by arduino uno
Materials	<ul style="list-style-type: none"> • The high priority of material is must low weight because the lighter is better to achieve sufficient lift. • The high priority of durability is needed because it must be able to withstand impact and abrasion. • The low cost is priority because the lowest is better.
Air bag skirt	<ul style="list-style-type: none"> • The designation of skirt of hovercraft must be perfect because it is depending either the hovercraft can be hover over the ground.