DESIGN OF UNDERWATER INSPECTION ROBOT MECHANICAL TRACK SYSTEM

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This report is submitted
in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled "Design Of Underwater Inspection Robot Mechanical Track System" is the result of my own work except as cited in the references.

Signature	:	....
Name	:	Mohamad Azizuddin Bin Mohd Azman
Date	:	....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation).

Signature	:.	....
Name of Supervisor	:	Ir. Dr. Tan Chee Fai
Date	:	....

ABSTRACT

The main purpose of this project is to design a track system for an underwater inspection robot. This track system needs to be more efficient than the conventional track system. Efficient in this case is measured in speed. The speed of the track system were increased based on the design of the track. The track conventional track system mainly have two sets of tracks on the side of the underwater inspection robot. However, the newly designed track system separate the two part track system into four parts. This allow the underwater inspection robot to move more quickly. The mechanism of army tanks has been switched to a mechanism of a conventional car that consist of four sets of tyres. Furthermore, by applying this design on the underwater inspection robot, it also helps reduce the overall weight of the underwater inspection robot. With a less weight, this the underwater inspection robot to move faster. However, the weight of the underwater inspection robot cannot be too light as it will result in making the underwater inspection robot to have difficulties gripping on to the ground. This is due to the buoyancy force that will make the underwater inspection robot afloat.

ABSTRAK

Tujuan utama projek ini dijalankan adalah untuk mereka cipta sebuah sistem trek untuk robot pemeriksaan bawah paras air. Sistem trek ini perlulah berfungsi dengan lebih baik berbanding sistem trek yang sedia ada di pasaran. Sistem trek baharu ini perlulah lebih mempunyai kadar kelajuan yang lebih tinggi. Kadar kelajuan telah pun ditingkatkan berdasar rekaan yang baharu. Sistem trek yang sedia ada dipasaran kebiasaannya mempunyai dua bahagian trek iaitu dibahagian kiri dan kanan robot. Walaubagaimanapun, rekaan terbaru sistem trek ini telah memecahkan bahagian daripada dua kepada empat. Rekaan sebegini dapat membantu robot untuk bergerak dengan lebih cepat. Mekanisma yang sebelumnya menggunakan kaedah kereta kebal askar telah ditukarkan kepada mekanisma kereta komersial yang menggunakan empat bahagian tayar untuk bergerak. Tambahan pula, rekaan empat bahagian tayar ini membantu mengurangkan berat keseluruhan robot. Robot yang lebih ringan tentunya dapat bergerak dengan lebih pantas. Walaubagaimanapun, robot pemeriksaan bawah paras air ini tidak boleh terlalu ringan kerana ia memerlukan berat yang ideal untuk memastikan ia dapat mencengkam lantai dengan baik. Hal ini dapat menjejaskan cengkaman itu sekiranya robot terlalu ringan kerana terdapat daya apungan terhadap robot yang membuatkan robot untuk terapung.

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LIST OF ABBEREVATIONS

OTR	Off The Road
CAD	Computer Aided Design
BoM	Bill of Material
HoQ	House of Quality
TS	Track System
-ve	Negative
3D	3 Dimension

LIST OF SYMBOL

π	Pi
$\circ$	Degree

CHAPTER I

INTRODUCTION

1.1 BACKGROUND

Underwater inspection are widely required worldwide. The practice usually demands human to went into the water and inspect whatever that need to be check. However, in globalisation era, there are robots that were built to do this kind of task. It is because the robot that were built can withstand the amount of pressure that human cannot bare. Furthermore, human requires oxygen to breath and this make it difficult as they need to bring along their oxygen supply, in order to stay longer in the water. It is easy for the robot as it doesn't requires any oxygen to operate, however, it needs to be waterproof to make sure the electronic devices that operates it doesn't get wet hence the fuse will damaged. Working underwater is both dangerous and difficult for humans.

Currently, there are many types of underwater inspection robots that in the market. There are the biomimetic lobster that mimic the biology or physical of a lobster. There are also underwater robots that only uses propeller to move around. The track wheeled underwater robots are also widely used in the current industry. All of this design are different however, it shares the same objective that is to do underwater inspection. These designs are proposed to overcome many types of environment. The world's oceans are home to the most strange and amazing creatures. So all of the creatures don't usually have the same habitat so there are few that are isolated deep down into the ocean where the ground is not level. So that's where the robot that uses only propeller get in handy. These underwater robots can record data that would be difficult for humans to gather.

However, not all underwater robot are designed to go into the sea. There many other places that needs underwater inspection for example a lake, a reservoir, a tank for storing waters and etc.

There are many types of system for the underwater inspection robot to move around. There are robots that uses wheel, propeller, claws and continuous track system. All of the system that were used has its own advantages and disadvantages. For example, the wheel system can be very fast and it has a longer life span. This is due to the surface area that were exposed to the frictional point is less compared to the continuous track system. However, the wheel actually have a problem when facing an uneven surface because the wheel and its shape will somehow stuck or damage while passing through an uneven surface. This is scenario is totally opposite from the continuous track system. The continuous track system can easily go through any uneven surface because of the design of assembling a series of wheel and combining them using a tread. However, the continuous track system maybe lack of speed and has a less option of maneuverability. This is because the series of wheel that were aligned can be too long for it to make a more flexible movement.

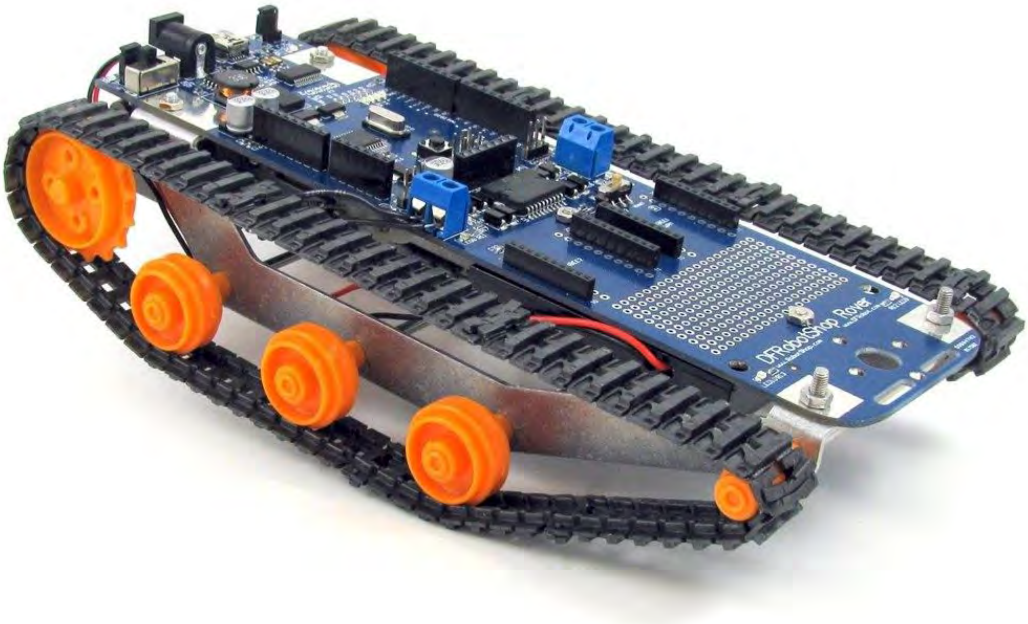

Figure 1.1 Track system robot.

(Source: Robotshop, 2016)

1.2 PROBLEM ST ATEMENT

The current underwater robot that were in the market are mostly using continuous track system. This type of system have a great power to move around however the speed of the robot are a bit slow. This affects the security of the robot if a situation that needs the robot to move away from danger immediately. It also have a shorter life span of its rubber tread as the surface area exposed to the surface are greater compared to normal wheel. The maneuverability of the robot also are quite restricted. This will make it difficult for it to explore even further into a problem that need solving.

1.3 OBJECTIVE

1. To increase the speed of the continuous track system

1.4 SCOPE

The scopes of this project are:

1. To focus on the continuous track system
2. To concentrate on the design of the track

1.5 GENERAL METHODOLOGY

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Literature review Journals, articles, or any materials regarding the project will be reviewed.

2. The suitable design for the whole continuous track system will be proposed.

3. If the design process of the track system has passed, the calculation process will take place to determine whether the design has fulfil the requirement needed in the objective.

4. The simulation of the track will be done using CATIA software. The maximum pressure of the track system will be tested in the software.

5. The result that was tested will be recorded and be placed to make comparison to further improve the system.

6. Report writing will be done at the end of the project.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses about the overview of the continuous track system. There are many types of continuous tracks that have been invented, therefore the track system is not a new thing to the market. Besides that, the material used to making a track is also plenty. There are tracks that only uses metal. There are also rubber tracks and there are tracks that combines both metal and rubber. The design of the tread is also crucial to consider the contact force between the surface of the ground and the tracks. There are V-shaped, U-shaped and also I-shaped treads in the current market. Finally, this chapter discusses about the dimension of the tracks. Should it be wide or skinny tracks? It will be discuss in this chapter.

2.2 CONTINUOUS TRACK

According to omicsgroup.org (2006), continuous track is a system that is driven by two or more wheels of the vehicle propulsion in which a continuous band of treads that is attached to it. The materials that were used are modular steel plates in the case of military vehicles, or rubber reinforced with steel wires in the case of lighter agricultural or construction vehicles. The vehicle have a large surface area of the tracks that have a purpose of distributing the weight of the vehicle better. This enables a continuous tracked vehicle to drive over soft ground with less possibilities of being stuck due to sinking.

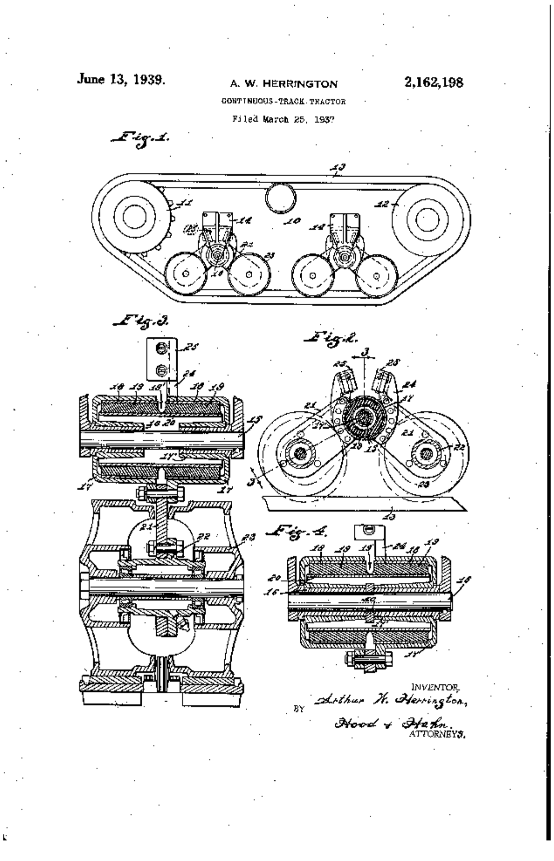

Figure 2.1 Dimension of existing continuous track system

(Source: Arthur, 1939)

The advantages of using metal plates as the tread are both hard-wearing and damage resistant. However, there are some disadvantages of using metal plates. One of it is that it will damage the paved surfaces. This sort of problem can be overcome by replacing metal plates with rubber pads that can be installed for use on paved surfaces to prevent the damage.

A continuous track system consists of two independently rotating rings, with a centre of rotation in the axis of the body. To each of those rings, an arm is attached on a rotary joint. These arms are similarly mounted to both sides of each track. This configuration allows various orientations of track with respect to the body. Each track unit is adjusted by two or more drives. Two drives allow rotation of rings in the robot body axis and the third drive positions one arm with respect to the track.

2.2.1 Hybrid Wheel And Track Vehicle Drive System

A hybrid wheel is similar to an ordinary car tyre system. It have four driving wheel but each wheel are mounted by their own band tread. Each part of the four tyre are the same. It only assembled in a suitable manners. Based on the Patern filed by Giovanetti (2004) a vehicle drive system includes a hybrid wheel and track system, having a drive wheel operably coupled to a motive source, the motive source for imparting rotational motion to the drive wheel, the drive wheel having an axis of rotation, an idler wheel displaced from the drive wheel and rotationally coupled to the drive wheel by a continuous track; and a cantilever beam supporting the idler wheel and being rotatable as desired about the drive wheel axis of rotation.

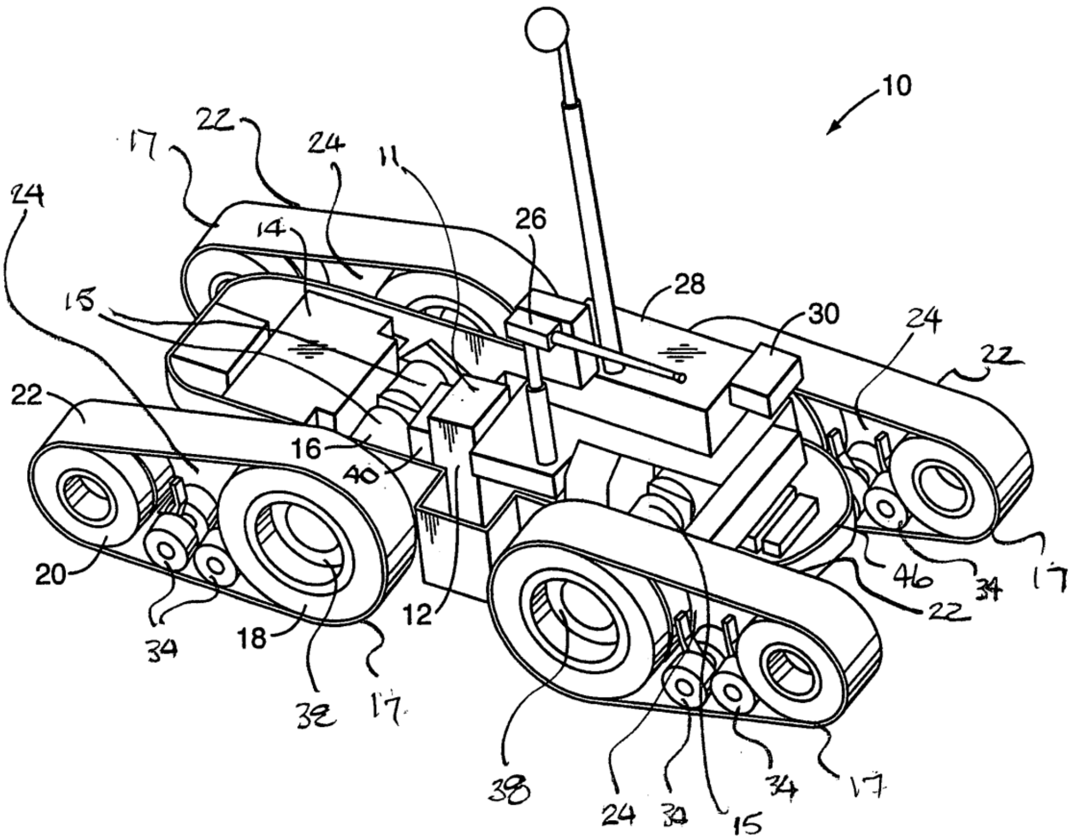

Figure 2.2 hybrid wheel and track vehicle drive system

(Source: Giovanetti ,2004)

2.2.2 Conventional Continuous Track System

As stated by Belotserkovskii (2014), the movement of heavy continuous track vehicles produces massive vibrations of the ground, generating surface waves that propagate over a long distance, causing damage to buildings. If these type of vehicles passing through is prohibited, seismographs are set up at the place of prohibition that record any infringement of the ban. As a result, the waves generated by continuous track vehicles have been extensively studied in recent years. A more simplified model of a drive was used in the study but the dynamic properties of a continuous track that has a periodic structure were not taken into consideration.