DESIGN AND DEVELOP ROBOT TRACKED VEHICLE PLATFORM FOR NAVIGATION AND RESCUE APPLICATION

MUHAMMAD HASIF BIN MOHD AZIRI

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Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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" I hereby declare that I have read through this report entitle "Design and Develop Robot Tracked Vehicle Platform for Navigation and Rescue Application" and found that it has comply the partial fulfillment for awarding the Bachelor of Mechatronics Engineering with Honours. "

Signature : ....

Supervisor's Name : Mr. Mohd Zamzuri Bin Ab. Rashid

Date : 06/01/2016

I declare that this report entitle "Design and Develop Robot Tracked Vehicle Platform for Navigation and Rescue Application" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....

Name : Muhammad Hasif bin Mohd Aziri

Date : 06/01/2016

Specially dedicated to my beloved parents, family and friends
for the variety of support, encouragement,
blessing and best wishes.

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ABSTRACT

This project proposes designing and developing a Robot Tracked Vehicle Platform (RTVP) for navigation and rescue application by using a parallel mechanism based on the track structure from the viewpoint of the tracked locomotion design. Recently, robot platform is used as a control robot for research and development in the area of technologies especially for search and rescue task as well as for domestic purposes. This robot in this project is a robot tracked platform that consist of four nine-inch wheels size and driven by 24V DC brush motor with 350W power and 2600RPM at maximum speed. The motor function of the RTVP is driven by 30A DC Motor Driver with current capability up to 80A and 40A continuously. The body of RTVP is made of aluminium hollow, steel and sheathing plywood which is combined with a modified off road motorcycle tire as a track structure. Besides, the right size of the wheel and the design of the chassis must be in an accordance for stable movement in order to always maintain a parallel state of the robot mechanism. The RTVP capable to move from the left side and the right side as well maneuver in straight line, turn back and rotate 360 degree. The RTVP is controlled by Romeo-All In One Controller (Arduino Compatible Atmega 328) powered by four(4) 12V/7.0Ah lead acid battery that can be controlled via a wireless connection by using the APC220 RF module. Overall, the RTVP is designed for a wider range of applications which is able adapt to the complex terrain environment such as climbing the obstacle and off road use with low cost of manufacturing.

ABSTRAK

Projek ini adalah cadangan untuk merekabentuk dan membangunkan sebuah robot trek platform bagi tujuan navigasi dan menyelamat dengan menggunakan mekanisma selari berdasarkan struktur trek dari sudut pandangan rekabentuk pergerakan trek. Pada masa kini, robot trek platform digunakan untuk tujuan penyelidikan dan pembangunan dalam bidang teknologi dan ianya juga turut digunakan secara meluas untuk tugas mencari dan menyelamat serta bagi tujuan domestik. Robot ini adalah robot trek platform yang terdiri daripada empat roda bersaiz 9 inci dan dipacu dengan 24V motor arus terus berkuasa tinggi iaitu 350W dengan kelajuan 2600 RPM dalam keadaan tanpa beban. Motor yang digunakan untuk robot ini dipacu oleh "30A DC Motor Driver" yang mampu untuk mengawal nilai voltan dan arus yang tinggi mengikut keupayaan semasa dari 40A hingga 80A secara berterusan. Robot ini diperbuat daripada aluminium hollow, besi dan papan lapis serta menggunakan tayar motorsikal lasak yang telah diubahsuai untuk dijadikan sebagai struktur trek. Di samping itu, saiz roda dan rekabentuk casis yang betul amat penting untuk mengekalkan kestabilan pergerakan robot trek melalui kaedah konfigurasi secara keadaan selari. Robot ini mempunyai kebolehan untuk berpusing ke kiri dan kanan, ke hadapan dan belakang dalam keadaan lurus dan berpusing 360 darjah. Robot ini menggunakan pengawal "Romeo-All In One Controller (Arduino Compatible Atmega 328)" dan empat(4) 12V/7.0Ah bateri asid plumbum serta radio frekuensi APC220 digunakan sebagai alat kawalan tanpa wayar bagi keseluruhan operasi robot trek. Secara keseluruhan, robot trek platform ini direka untuk pelbagai aplikasi yang dapat beroperasi dalam persekitaran yang lasak dan ekstrim dengan kos yang rendah.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE

CHAPTER	TITLE	PAGE

LIST OF TABLES

LIST OF FIGURES

FIGURE	TITLE	PAGE

LIST OF SYMBOLS

Ah	-	Ampere per hour
D,d	-	Diameter
DC	-	Direct current
F	-	Force
FEA	-	Finite element analysis
FYP	-	Final year project
g	-	Gravity = 9.81 m/s
l	-	Lenght
m	-	Mass
P	-	Pressure
PWM	-	Pulse width modulation
r	-	Radius
SW	-	Switch
θ	-	Angle
t	-	Time
h	-	Height
V	-	Volt
RTVP	-	Robot Tracked Vehicle Platform

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This project proposes designing and developing a Robot Tracked Vehicle Platform (RTVP) by using the parallel mechanism based on the track structure from the viewpoint of the tracked locomotion design. The RTVP capable to move from the left side and the right side as well maneuver in straight line, turn back and rotate 360 degree. On top of that, the RTVP is a robot tracked platform that consist of four nine-inch wheels size and driven by 24V DC brush motor with 350W power and 2600RPM at maximum speed. The motor function of the RTVP is driven by 30A DC Motor Driver with current capability up to 80A and 40A continuously. The body of RTVP is made of aluminium hollow, steel and sheathing plywood which is combined with a modified off road motorcycle tire as a track structure. In addition, this robot is controlled by Romeo-All In One Controller (Arduino Compatible Atmega 328) and powered by a by four(4) 12V/7.0Ah lead acid battery that can be controlled via a wireless connection by using the APC220 RF module. The RTVP is controlled by Romeo-All In One Controller (Arduino Compatible Atmega 328) powered by four(4) 12V/7.0Ah lead acid battery that can be controlled via a wireless connection by using the APC220 RF module. Overall, the RTVP is designed for a wider range of applications which is able adapt to the complex terrain environment such as climbing the obstacle and off road use with low cost of manufacturing.

1.1 Motivation

Recently, robotics are used for many genuine application in real world. Two essential that firmly connected ranges of use are robotic exploration, search and rescue includes investigation of areas that are dangerous and out of reach to people. There are several situation without putting human responders at danger such as in mine fields, polluted zone, different planets, submerged situations or underwater environments. The uses of rescue robot is highlited during rescue the breakdown of the Word Trade Center in New York in 2001, which is reqiured for groups of robots to give broad help with inquiry and salvage undertakings. So, it is additionally important to create a controlled robot that ca be used for extremely facisnating fields of exploration such as navigation, mapping, casualty detection, correspondence and improvement of a practical human-robot interface.

Figure 1.1: Search and Rescue Robot [1][12]

This work and research of this project is conducted at the Universiti Teknikal Malaysia Melaka (UTeM). The main reason to conduct this project is to design and develop the RTVP can provide excellent stability, traction and low ground bearing pressure in order to achieve and perform for any hostile working conditions. Moreover, the size of the robot is 762mm x 635mm x 254mm which is very expensive to buy it from the market. The price on the market for large scale size of the robot is around RM 12,000 - RM 25,000 but the total cost for this project is only RM 2300. So, this project will produce large scale of RTVP with low cost of manufacturing. Therefore, the project needs to be successful and able to implement it perfectly.

1.2 Problem Statement

Recently, robot platform is used as a control robot for research and development in the area of technologies, especially for search and rescue task as well as for domestic purpose. However, the robot platform needs a perfect locomotion mechanism to move in smooth and stable throughout its environment. But, the selection for robot platform design has a large variety of possible ways for the selection of a robot's approach such as wheeled, tracked and legged locomotion system. The key issues for tracked locomotion mechanism is the compliment of manipulation which is sharing the same core issues of contact characteristic, stability and environmental type such as:

1. **Characteristic of Contact** : Path size, contact point, angle of contact, friction and shape.
2. **Stability** : Center of gravity, geometry of contact points, inclination of terrain, static and dynamic stability.
3. **Environmental Type** : Structure and medium (e.g. Obstacle or uneven surface and hard ground).

Based on the issues of the tracked locomotion mechanism, the perfect features are necessary in order to provide heavy-duty and excellent stability of robot platform that can perform admirably in any hostile working conditions.

1.3 Objectives

The objectives of this project are:

i. To design and develop Robot Tracked Vehicle Platform by using SolidWorks premium 2013 by identify the size and the parts functionality of the robot.

ii. To develop a communication system between Robot Tracked Vehicle Platform with PC by using the APC220 RF module.

iii. To analyze the movement of the Robot Tracked Vehicle Platform that can go over the obstacles and move in an uneven surface.

1.4 Scope of the Project

The scopes of this project are:

i. Design a Robot Tracked Vehicle Platform by using Romeo-All in one Controller (Arduino Compatible Atmega 328). The weight of the robot is 35kg and the size is 48 inch x 36 inch x 9 inch.

ii. The Robot Tracked Vehicle Platform that can move in an uneven surface and over obstacles by using a 24V DC brush motor with 350W power which is driven by 30A DC Motor Drivers.

iii. The communication system of the Robot Tracked Vehicles Platform using the APC220 RF module is linked with the Arduino Romeo-All In One that is programmed in Matlab environment to control the behavior of the robot.

iv. Provide excellent stability, traction and low ground bearing pressure in order to achieve and perform for any hostile working conditions.

1.5 Summary

This chapter covers about motivation, problem statement, objectives and scopes for this project. Motivation part describes about the main reason to design and develop Robot Tracked Vehicle Platform and for problem part is about statement issues of the tracked locomotion mechanism. Lastly, the objectives and scopes of this project is to develop and design hardware with communication system by using RF modules and analyze the behavior of robot platform.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The system design and locomotion modes as well as analysis and experimental works of existing projects will be focused for this chapter. This chapter also will review and discuss about existing robot tracked in term of difference and the similarity of the previous project. The main sources for review this project are from journals and reference books.

2.2 The Existing Mobile Robot with Tracked Locomotion Mode

The research about robot for this part is about the existing mobile robot that using a tracked locomotion mode. There are many number of comercial robot that available for any field of applications. Most of these robots are designed from research academic intitusions such as fire fighting, chemical and radioactive installations, reconnaissance operations, anti terrorism activities, etc [1]. The most common of these mobile robot with tracked locomotion mode will explain details in this topic.

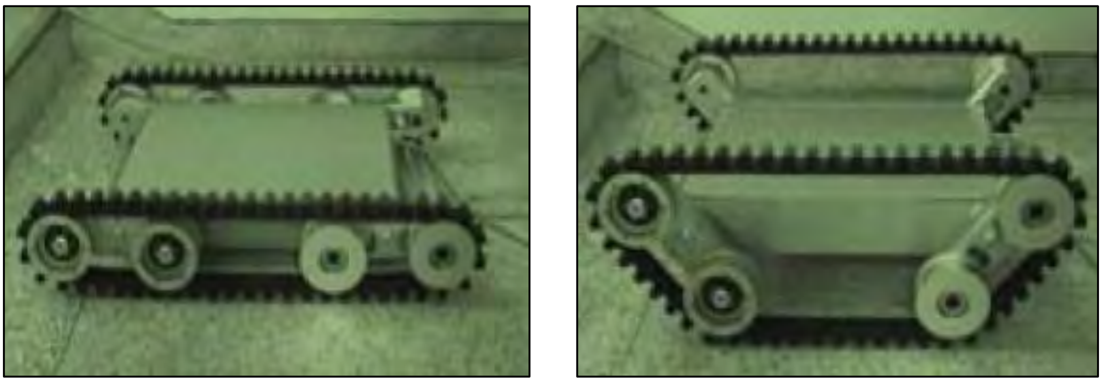
2.2.1 MOBIT, A Small Wheel -Track- Leg Mobile Robot [2][3]

MOBIT was designed by Xingguang Duan, Qiang Huang and Nasir Rahman had different locomotion modes for outdoor and indoor enviroments [2]. It was small robotic platform that were combinations of legs, tracks and wheels which makes the robot high capability and good adaptability to move with different locomotion modes. This robot was confirmed by experiments such as traversing step, posture recovering, tipped over and as climbing stairs[3]. Figure 2.1 shows the physical figure of MOBIT robot.

Figure 2.1: MOBIT robot [2][3]

2.2.2 Obstacle Negotiation for the Rescue Robot with Variable Single-tracked Mechanism [4]

According to [4], the robot was developed to provide a practical introduction for a rescue operations. This robot able to overcome obstacles such as stairs because it had a variable single-tracked mechanism for the driving part. It had two driving mode such as the robot estimate whether or not any obstacles are there and the robot recognizes the forward environment once. The robot was tested in reflecting the proposed algorithm and opposition to several obstacles ultimately. Figure 2.2 shows the mode transformation of VSTR.



Mode 1 Mode 2

Figure 2.2 : Mode Transformation of VSTR [4]