FAKULTI KEJURUTERAAN ELEKTRIK

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LAPORAN PROJEK

SARJANA MUDA

CRAWLER TYPE ROBOT

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Bachelor of Mechatronics Engineering

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"I hereby declare that I have read through this report entitle "Crawler Type Robot" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronics Engineering"

Signature	:	…………………………………….
Supervisor's Name	:	…………………………………….
Date	:	…………………………………….

CRAWLER TYPE ROBOT

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This Report Is Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Mechatronics Engineering

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

"I declare that this report entitle "Crawler Type Robot" 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 : ………………………………….

Date : ………………………………….

To my beloved mother and father

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ABSTRACT

Nowadays, the crawler type robots are widely used in rescuing and inspection missions. Therefore, crawler type mechanism is kept improving so it can be applied on various type of terrains with better performance. However, most of the existing crawler type robots available now are not moving consistently in one direction. In other words, it cannot move according to our desired direction properly. This project is undertaken with the aim to design and develop a crawler type robot which can pass through several types of terrain as well as to analyze and evaluate the performance of developed crawler type robot in term of its accuracy and repeatability. The scope of this project is focused on the performance test of robot's accuracy and repeatability with respect to its speed on regular and irregular terrains. Moreover, the terrains involved in this project are focus only on flat surface, rough surface and stairs as well. This project presents the analysis of the developed crawler type robot's performance by collecting the data during the experiment. The experiment conducted here consists of two research methodologies: lab test and field test. Lab test is conducted on flat surface and stairs while field test is conducted on rough surface. Both of the experiments measure the performance (accuracy and repeatability). Besides that, the robot was also been tested on its capability of climbing the stairs. However the study was limited only to the flat surface, rough surface and stairs. For recommendation, it should cover the study of suspension system on more irregular terrains with extreme conditions such as underwater, sand and mud. Moreover, it should also include different types of controller such as PI, PD and PID controller.

ABSTRAK

Sejak kebelakangan ini, robot jenis merangkak telah digunakan secara meluas dalam misi menyelamat dan pemeriksaan. Oleh itu, mekanisme tersebut terus diperbaiki supaya ia dapat digunakan di atas pelbagai bentuk permukaan bumi dengan prestasi yang lebih baik. Walau bagaimanapun, kebanyakan robot yang sedia ada pada masa kini tidak dapat bergerak pada satu arah secara konsisten. Projek ini dijalankan dengan tujuan untuk mereka bentuk dan menghasilkan robot yang berupaya untuk bergerak di atas pelbagai jenis bentuk permukaan bumi. Selain itu, objektif tersebut juga merangkumi penilaian robot semasa ia beroperasi dari segi ketepatan dan kebolehulangan. Skop untuk projek ini hanya fokus terhadap ujian prestasi robot di atas permukaan rata, kasar dan tangga sahaja. Projek tersebut menunjukkan analisis prestasi robot dengan mengumpul data semasa eksperimen dijalankan. Terdapat two jenis penyelidikan metodologi dalam project ini, iaitu ujian makmal dan ujian lapangan. Ujian makmal dijalankan pada permukaan rata manakala ujian lapangan dijalankan di atas permukaan kasar. Kedua-dua eksperimen menilai prestasi robot (ketepatan dan kebolehulangan). Selain itu, ujian kebolehan robot untuk menaiki tangga turut dijalankan. Walau bagaimanapun, kajian tersebut adalah terhad kepada permukaan rata, kasar dan tangga sahaja. Sebaliknya, kajian ini harus merangkumi sistem penggantungan di atas pelbagai jenis bentuk permukaan yang lain seperti dalam air, padang pasir, dan lumpur. Selain itu, pelbagai jenis pengawal seperti PI, PD dan PID juga harus dikaji.

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CHAPTER 1

INTRODUCTION

1.1. Motivation

Japan was recognized as one of the advanced countries nowadays due to its rapid development of technologies. But unfortunately, an unwanted incident occurred on March 11, 2011. The earthquake with Richter magnitude scale of 9.0 causes a tsunami which hit the Tohoku area in Japan. As a result, several nuclear plants were damaged and the radioactive materials were spread out widely nearby those areas. [22]

The extreme situation makes the rescue and inspection missions more difficult to be performed at that time due to high radiation environment. Therefore, they decided to use mobile robots to perform the tasks instead of human beings because human cannot be exposed to highly radioactive materials for long period of time. [22]

Figure 1.1 shows the rescue mobile robots, named Quince robots which designed for searching and rescuing mission purposes. Quince robot consists of 4 crawler legs which are flexible to move over any type of terrains. Besides that, the mechanism of this robot also makes it to able to climb over the stairs. However, the movement of climbing the stairs might be slow if compared to its movement on the ground.

Figure 1.1 Quince robots [22]

Figure 1.2 shows the statistics of human and economic losses in Japan due to the disasters that happened since year 1980 to 2010. It shows that 157 of events were occurred within this 31 years and 8 568 people were killed. Average people killed per year are about 276 people. However, the economic damage is about 208 billion US dollars over 31years of natural disasters. There were nearly 6.7 million US dollars of economic damage per year in Japan due to the disasters. [18]

Natural Disasters from 1980 - 2010

Overview

No of events:	157
No of people killed:	8,568
Average killed per year:	276
No of people affected:	3,361,979
Average affected per year:	108,451
Economic Damage (US$ X 1,000):	208,230,800
Economic Damage per year (US$ X 1,000):	6,717,123

Figure 1.2 Natural disasters from year 1980 to 2010 [18]

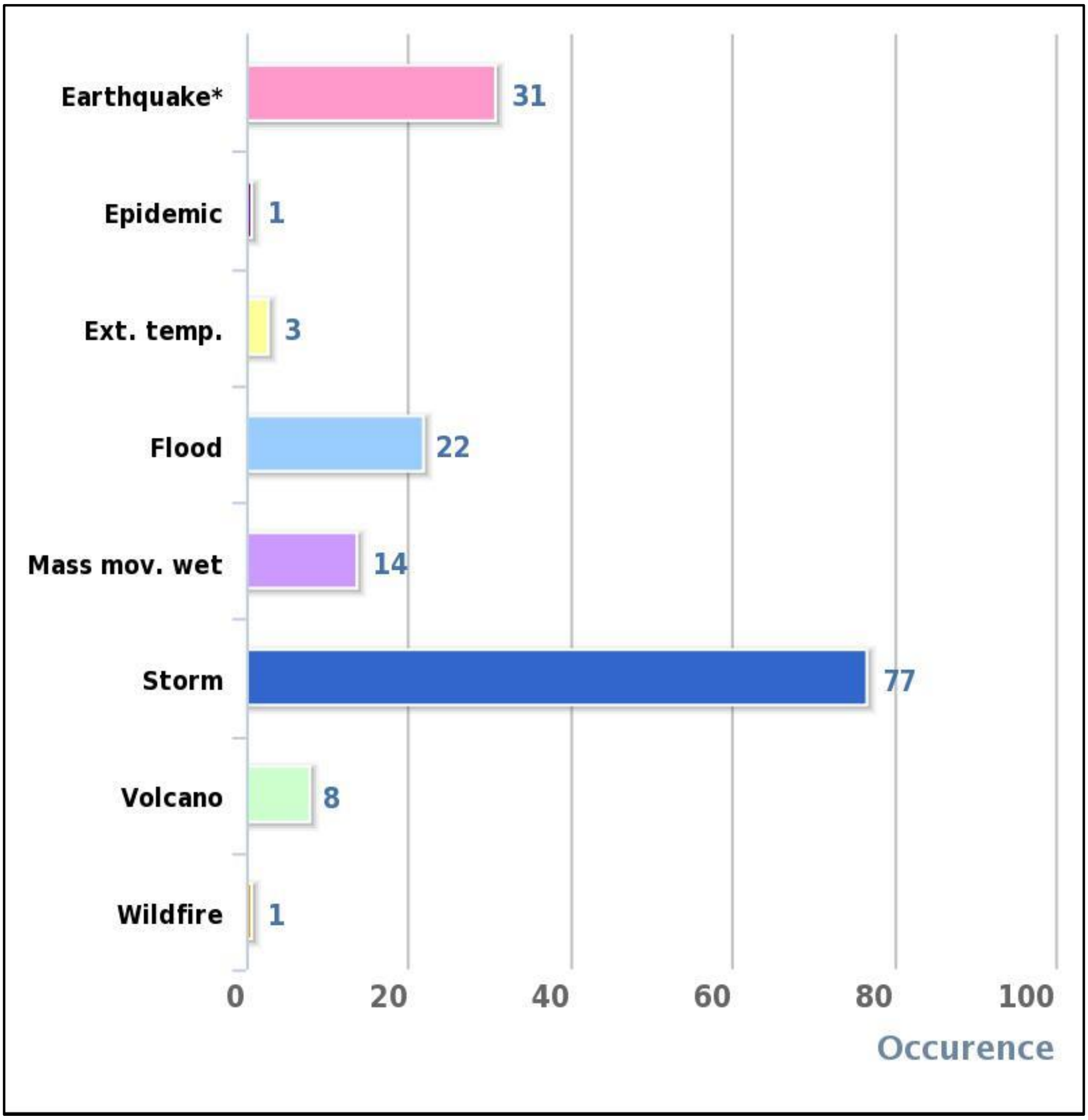

Figure 1.3 Natural disaster occurrence reported [18]

Figure 1.3 shows the statistics of natural disaster occurrence reported in year 1980 to 2010. The highest occurrence was the storm (77 occurrences) and earthquake was in second place (31 occurrences) after storm. Then follow by the flood which contributes to 22 occurrences. Figure 1.4 shows the average disaster per year based on the data in Figure 3.1.

Average Disaster Per Year

Drought:	...
Earthquake*:	1.00
Epidemic:	0.03
Extreme temp:	0.10
Flood:	0.71
Insect infestation:	...
Mass mov. dry:	...
Mass mov. wet:	0.45
Volcano:	0.26
Storm:	2.48
Wildfire:	0.03

Figure 1.4 Average disasters per year [18]

Figure 1.5 shows the data of top 10 natural disasters reported based on 3 categories: affected people, killed people and economic damages. The highest number of people affected and killed due to natural disasters was the earthquake. Earthquake contributes also the most severe economic damage to Japan. Figure 1.6 shows the statistics per event based on data in Figure 1.5.

Top 10 Natural Disasters Reported

Affected People

Disaster	Date	Affected (no. of people)
Earthquake*	1995	541,636
Flood	2000	360,110
Storm	2005	270,140
Storm	2004	180,050
Storm	2000	180,041
Flood	1986	162,000
Storm	1982	140,000
Storm	2002	100,018
Storm	1991	91,128
Storm	1990	87,778

Killed People

Disaster	Date	Killed (no. of people)
Earthquake*	1995	5,297
Flood	1982	345
Earthquake*	1993	239
Storm	1983	131
Mass mov. wet	1983	117
Earthquake*	1983	102
Storm	1982	100
Storm	2005	100
Storm	2004	89
Storm	2004	88

Economic Damages

Disaster	Date	Cost (US$ X 1,000)
Earthquake*	1995	100,000,000
Earthquake*	2004	28,000,000
Earthquake*	2007	12,500,000
Storm	1991	10,000,000
Storm	2004	9,000,000
Flood	2000	7,440,000
Storm	1999	5,000,000
Storm	1990	4,000,000
Storm	1998	3,000,000
Storm	2006	2,500,000

Figure 1.5 Top 10 natural disasters reported [18]

Statistics Per Event

Killed People

Drought:	...
Earthquake*:	185.58
Epidemic:	...
Extreme temp:	46.00
Flood:	29.18
Insect infestation:	...
Mass mov. dry:	...
Mass mov. wet:	32.43
Volcano:	5.50
Storm:	19.96
Wildfire:	...

Affected People

Drought:	...
Earthquake*:	24,989.84
Epidemic:	460.00
Extreme temp:	6,100.00
Flood:	32,522.77
Insect infestation:	...
Mass mov. dry:	...
Mass mov. wet:	1,836.14
Volcano:	11,243.75
Storm:	22,560.45
Wildfire:	222.00

Economic Damages

Drought:	...
Earthquake*:	4,699,077.42
Epidemic:	...
Extreme temp:	...
Flood:	514,104.55
Insect infestation:	...
Mass mov. dry:	...
Mass mov. wet:	15,000.00
Volcano:	1,250.00
Storm:	662,715.58
Wildfire:	...

Figure 1.6 Statistics per event [18]

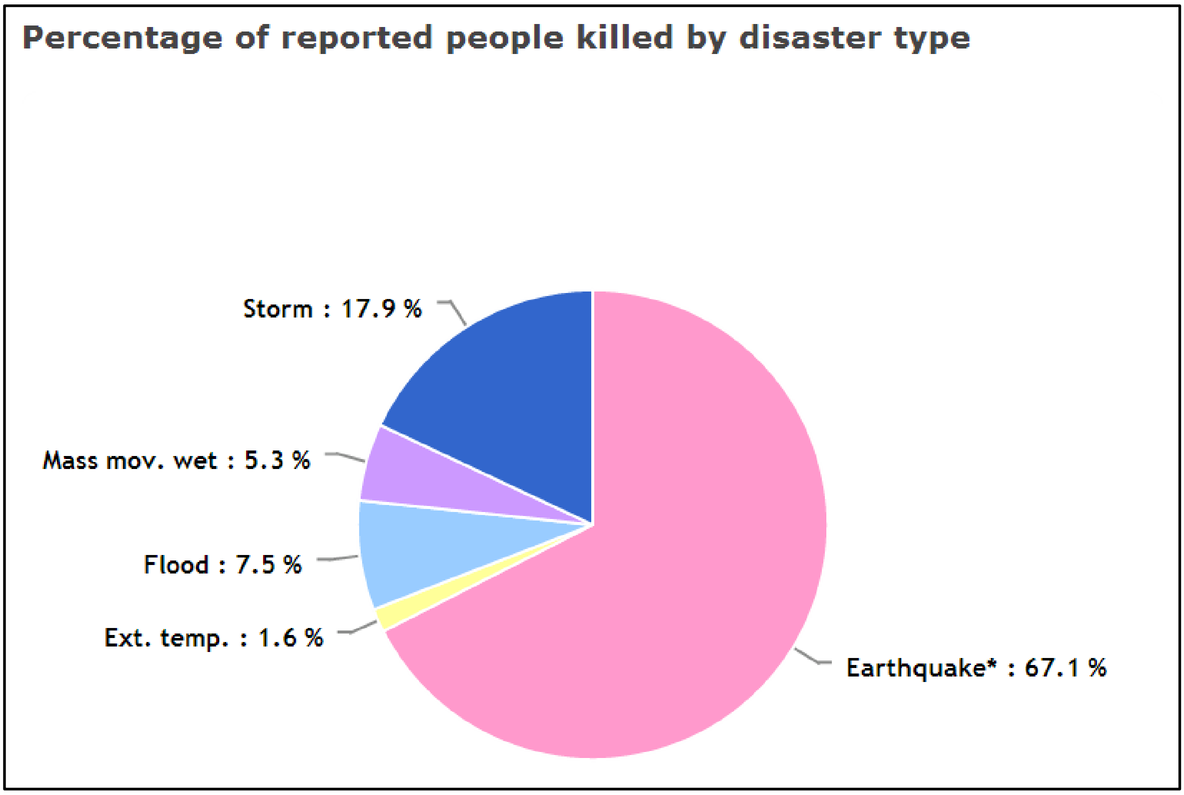

Figure1.7 Percentage of reported people killed by disaster type [18]

Figure 1.7 shows the statistics of reported people killed by disaster type in term of pie chart. Earthquake contributes the highest portion of this pie chart which constitutes of 67.1% of the pie chart. However, storm constitutes of 17.9% of the pie chart, follow by the flood (7.5%), mass movement wet (5.3%) and extreme temperature contributes the least portion of the pie chart, which is only 1.6% of the pie chart.

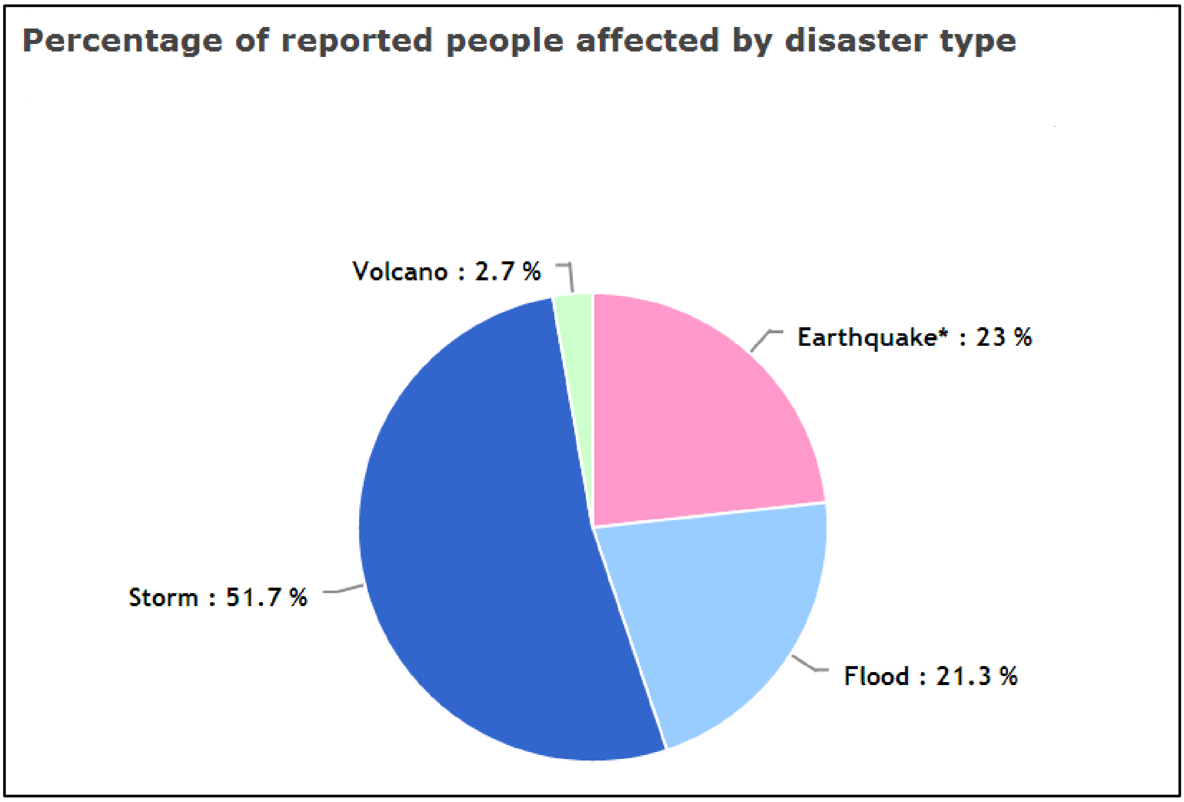

Figure 1.8 Percentage of reported people affected by disaster type [18]

Figure 1.8 shows the statistics reported people affected by disaster type in term of pie chart. Storm contributes the highest portion of this pie chart which constitutes of 51.7% of the pie chart. However, earth quake constitutes of 23% of the pie chart, follow by the flood (21.3%) and volcano contributes the least portion of the pie chart, which is only 2.7% of the pie chart.