TRACKING OF MOVING ROBOT BY A MOVING ROBOT USING VISUAL INFORMATION

KHAIRIL ANWAR BIN SAPEIA

The Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor Degree of Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

APRIL 2007

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : Tracking of Moving Robot by a Moving Robot using a Visual Information

Sesi Pengajian : APRIL 2007

Saya KHAIRIL ANWAR BIN SAPEIA

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)

4 MEI 07

(COP DAN TANDATANGAN PENYELIA)

ANIS SUHAILA BT MOHD ZAIN

Pensyarah

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer (FKEKK)

Universiti Teknikal Malaysia Melaka (UTeM),

Karung Berkunci 1200,

Ayer Keroh, 75450 Melaka

"I hereby declare that this report is the result of my own work except for quotes as cited in the references."

Signature :.....

Author :.....KHAIRIL ANWAR B. JAFEIA

Date :.....4 MEI 07

"I hereby declare that I have read this report and in my opinion this report is sufficient in termsof scope and quality for the award of Bachelor of Electronic Engineering (Computer Engineering) with honours."

Signature : .....

Supervisor's Name : ANIS SUHAILA MOHD ZAIN

Date : 4 MEI 07

Mom and dad, the siblings, family, teachers, lecturers, and friends all over Malaysia.
Thank you and Assalamualaikum.

ABSTRAK

Projek ini diimplimentasi menggunakan teknik penglihatan komputer yang dibina melalui bantuan Lego Mindstorm sebagai platform. Misi utama projek ini adalah untuk membina robot yang bergerak daripada binaan komposisi Lego Mindstorm yang berkebolehan untuk 'menangkap' sebuah lagi robot yang sedang bergerak. Ini dilakukan dengan memindahkan 'frame' daripada kamera yang dipasangkan pada robot yang diprogramkan untuk 'menangkap' robot yang satu lagi dan dihantar pada komputer untuk dianalisa menggunakan pengesan warna atau teknik penglihatan komputer. Proses penghantaran data itu dilakukan oleh kamera yang terletak di atas bahagian robot yang diprogramkan untuk 'menangkap'. Projek ini menggunakan program aturcara C sebagai algoritma untuk pergerakan dan fungsi 'sensor' dan perisian RoboLab sebagai antara muka untuk kamera. Projek ini boleh diaplikasikan kepada sistem keselamatan gudang bagi mengesan pergerakan imej asing.

ABSTRACT

This project implements using a computer vision techniques on the LEGO-MINDSTORMS platform, the goal of this project was to built moving Lego platforms (i.e. cars) and to establish a pursuit of one car after another car, this is done by transmitting frames from the camera onboard the persuiting car to a PC, analyzing each frame using color detection and other computer vision techniques thus locating the chased car, and transmitting movement commands, to the persuiting car. The Bricx Command Center (.nqc) programming language is used to develop the whole movement of both car, as well as the sensor and to be specific Robolab is used to build-up the user interfaces for camera to interact between the users and outside. This project can be applied to a security system in a warehouse.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

CHAPTER I

INTRODUCTION

1.1 INTRODUCTION OF THE PROJECT

Referring the title of the project - Tracking of Moving Robot by a Moving Robot Using Visual Information. In a simple application, this project can be applied to the security unit. Using this innovation, the security jobs become easier because they have an 'assistant' to assist their job to monitor, watch over and protect a certain region. We can't even know what should or could happen in future, but when the dangerous situations happen suddenly, we need to be prepared. We have to ensure all things that need in that time is in well condition. For example if the warehouse is under attack, the securities need a quick movement to determine the problem. But it is still taking a few times. At that time we didn't know how much the loss, so to overcome this problem; we need to set up a system that can act like a 'human eyes'. Can detected and captured the weird movement and send the data to the central to make some analyze depends on the procedure before the final decision can be send to the security for further action. This method can be done in a few minutes, and we have much time to construct the strategies.

So we can highlight a few benefits from this project:-

i. Decreasing an actionable time.
ii. Reducing a human error because this system using a camera those build on the robot.
iii. Increasing a précising of a certain task with a systematic method by a data analyzation.

In the context of vision and visual perception, is the way in which objects appear to the eye based on their spatial attributes, or their dimensions and the position of the eye relative to the objects. As objects become more distant, they appear smaller, because their angular diameter decreases. The Sun and the Moon appear to be roughly the same size because the Sun, although much, much larger, is also much farther away. The relationship between distance and apparent height of objects is not a linear pattern. If an object were actually touching the eye, thus being no distance away, it would appear infinitely tall [9]

.

From the statement above, we can realize how important that the visual role in our life. Starting with the eyes captured what there are attracting for. Then the information will be sending to our brain system to analyze and stated what they are. Basically, this project is about how the visual can assist the robot or human to get the information or data without using 'real' eyes. As a human being, we just don't have any perfect system. In other word, every single deed still has their mistake. There is no one security guard in this world can stand for 24 hours just to monitor the big wide warehouse. So, we have to develop a system to assist the security system to monitor the warehouse. Hopefully, the idea of this project can be applied to this situation and could be overcome the problem.

Furthermore, this project is using a two set of Lego Mindstorm, a web camera, a personal computer and a chased scene. The C programming language or NQC, as well as RoboLab as a developer of the robots movement and the user interfaces. In this task to track chased robot, we used a camera to detect the size and color of the sticker that stick on that car (chased) body. Then the data will be analyzed via PC to confirm the recent position of the chased car to the chasing car.

1.2 PROBLEM STATEMENTS

i. There are variety of Lego bricks colors plus the colorful scenery of the background (in the labatory). It is hard to sensor to detect the specific colors that have been programmed before.

ii. The subject of color and shape detection is troublesome when it is implemented in such a pursuit where there is a change of target angle and the position of the camera, it creates different lighting conditions and reflections, which makes the color detection much harder.

iii. The shape of the Lego model is outdated and not stylish. The shape of the bricks is not suitable in certain part. Lack of idea to assembled all the bricks in one color or in an attract decoration.

iv. The two robots were moving randomly in 2ft by 3ft chased scene. The chances of being hit or collide are high.

v. There is a problem in order to ensure both of the robots to move accurately according to a plan due to a faulty robot navigation source code.

1.3 OBJECTIVES

i. To reduce the color detection problem using a histogram of the environment (in HS color space).

ii. To achieve the precise target angle and the camera position of the robot.

iii. To create or modify the robot body into the stylish mode.

iv. To minimize the colliding impact.

v. To follow the black lines using Lego IR sensors.

1.4 SCOPE OF PROJECTS

The scope of these projects is including software and hardware. The software part we will use C program as a programming language. Then we need to transfer the programming source code using personal computer. We use transmitter and receiver to process or analyze the data from the RCX unit. This project can only move in between 2 x 2 meter per square. The most important is, when we want to use this project (demo) we must use it in the white room. This is to avoid any color detection problem.

1.5 METHODOLOGY

In order to complete this project, both software and hardware approach is used for implementation purpose:-

1.5.1 Software

'C' Programming and Bricx Command Center (.nqc)

- This two programming language is used to implement the motion of the car, detecting the chased car in the frame, color, and the shape of the sticker. The reason why this project used 'C' programming is because this language are defined as a high programming language besides a lot of software product in market is using this type of language. Bricx Command Center is LEGO software.

RoboLab Programming

- This type of programming language is used to develop a visual algorithm. It is important in order to arrange the step of the visual analyzing.

1.5.2 Hardware

Set of LEGO Mindstorm

- Including moving, versatile, simple and fun to build platform, which is flexible enough to fit the vehicles purpose, The chased car - uploaded with an escape program, and has a Lego structure which includes the two colors which are to be searched in 3 directions, The chasing car - uploaded with a program which changes the movement nature according to an inner variable, has the cordless camera onboard, and a shield from light above it to prevent reflections as much as possible.

Set of communication equipment

i. *RCX unit* - Small programmable unit by LEGO based on the H8 by Hitachi, provides serial I/O, A/D, 16k ROM, 32K RAM and timers. can be loaded up to 6k of programs , it produce voltage to two side engines which control the vehicle according to the value of an inner variable which can be changed while running by the program via pc.

ii. *Camera* - Transmits the image captured by the lens to the receiver which is connected to the computer via the video card so it can be analyzed by it later.

iii. Personal Computer

The Chase Scene

- The corner of a room at the vision and image science laboratory its important to emphasis that it wasn't changed in any way to ease the chance by removing colors which are the same or similar to the searched colors only the combination of the two colors attached mustn't exist in the room.

1.6 THESIS ORGANIZATION

Basically, this thesis is divided into five big chapters which consist of:-

Chapter I

- This chapter will introduce the whole of the project concept including the introduction, problem statements, objectives, scope of projects and methodology was explain generally.

Chapter II

- Chapter II is about the literature review of this project. The history and detail about LEGO Mindstorm, the evolvement of this entity is being discussed briefly. Moreover, the function of Brixx Command Center and RoboLab as a algorithm to this project was kindly be explain deeply in this chapter. Also the body of both robots. How the body was designed by a Google SketchUp.

Chapter III

- One of the important parts of this project. Methodology is including the hardware and software approach to develop the main objective of this project. This section will be discussing theoretically and practically about the method. Such as the procedure of assembling both robots body, and the flow of the project before develop using C programming language were describe deeply.

Chapter IV

- This chapter starts with an introduction of project discussion generally before going deeply into the problem that was occurred and the implementation method taken to solve the problem. Results are about the project finding such as the robots achievement during the demonstration.

Chapter V

- The final part that consists of the conclusion that made from the observations and findings process. Lastly the recommendation or what can we do to up grade the project for future purpose.

CHAPTER II

LITERATURE REVIEW

2.1 THE ROBOT EVOLUTION

A robot is a mechanical or virtual, artificial agent. A robot is usually an electro-mechanical system, which, by its appearance or movements, conveys a sense that it has intent or agency of its own. The word robot can refer to both physical robots and virtual software agents, but the latter are often referred to as bots [3]. For robotic engineers, the physical appearance of a machine is less important than the way its actions are controlled. The more the control system seems to have agency of its own, the more likely the machine is to be called a robot. An important feature of agency is the ability to make choices. So the more a machine could feasibly choose to do something different, the more agencies it has. For example, a Clockwork car is never considered a robot, a radio-controlled car is almost never considered a robot (though is sometimes known as a telerobot), a car with an onboard computer, like Bigtrak, which could drive in a programmable sequence might be called a robot, a self-controlled car, like the fictional KITT, which could sense its environment, and make driving decisions based on this information would quite likely be called a robot and more.

There is no one definition of robot which satisfies everybody, and many people have written their own. For example, International standard ISO 8373 defines a "robot" as:

An automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications.

Joseph Engelberger, a pioneer in industrial robotics, once remarked:

I can't define a robot, but I know one when I see one.

The Cambridge Online Dictionary defines robot as:

A machine used to perform jobs automatically, which is controlled by a computer.

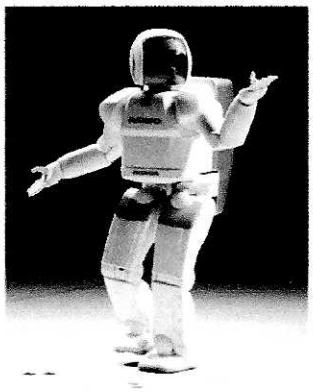

Figure 2.1: *ASIMO, a humanoid robot manufactured by Honda*

2.2 HARDWARE

2.2.1 LEGO Mindstorm

Figure 2.2: *LEGO Mindstorms, pioneer in robotic education*

The MINDSTORMS is a product of LEGO that allows one to build robots. At the core of this product range is the Robotics Invention System (RIS). The RIS (as of version 2.0) kit consists of 718 individual parts -of which 129 are unique LEGO parts. It includes motors, touch sensors, light sensors, infrared transmitter, bricks, pulleys and gears [2].

The outfit for both robots is using Lego Mindstorms. The suitable bricks size is selected to develop the body. This kit is including two DC motor, and several gears with different sizes and function that connected between the wheel and the motor. Lego Mindstorms is a line of Lego Group robot kits combining programmable bricks with electric motors, sensors, Lego bricks, and Lego Technic pieces (such as gears, axles, beams, and pneumatic parts) to build robots and other automated or interactive systems. Lego Mindstorms is marketed commercially as the Robotics Invention System (RIS). It is also sold and used as an educational tool, originally through a partnership between Lego and the MIT Media Laboratory [1]. The educational version of the products is called Lego Mindstorms for Schools, and comes with the ROBOLAB GUI-based programming software, developed at Tufts University using the National Instruments LabVIEW as an engine. Lego Mindstorms may be used to build a model of an embedded system with computer-controlled electromechanical parts. Almost all kinds of real-life embedded systems, from elevator controllers to industrial robots, may be modeled using Mindstorms. There is a strong community of professionals and hobbyists of all ages involved in the sharing of designs, programming techniques, and other ideas associated with Lego Mindstorms.

The original Mindstorms RIS was released in 1998. In 2006, Lego announced a next-generation Mindstorms system called NXT, centered on a new programmable brick. The product is actually the result of two separate research and innovation processes. The first process is represented by the LEGO Company's continuous development of new products since the first appearance of a reusable brick in 1949 (the "Automatic Binding Brick"), that led also to the creation of the TECHNIC series in 1977. The TECHNIC sets opened up new ways for children and adults to create working models of increasing complexity. The second process stems from research conducted at the Epistemology and Learning Group at the MIT Media Laboratory, led by Fred Martin, Brian Silverman and Randy Sargent under the guidance of Professors Seymour Papert and Mitchel Resnick and support from the LEGO Company. This work, which is started in 1986, lead to the development of so-called "Programmable Brick", a small unit capable of connecting to the external world through a variety of sensors and actuators, designed for the creation of robots and other applications in which a computer might interact with daily subjects.

The sum of these two efforts brought life to the RCX, a microcomputer by the LEGO Company based on the technology developed at Media Lab for the MIT Programable Brick. The RCX was featured with sensors and other special parts taken from the LEGO TECHNIC series and specifically designed software capable of interfacing with a standard PC [7].