Sudan University of Science and Technology
College of Engineering
School of Electronic Engineering

Design of LINE FOLLOWER ROBOT USING PID CONTROLLER

تصميم روبوت لتتبع المسار باستخدام التحكم التناسبي التكاملي التفاضلي

A Research Submitted in Partial Fulfillment for the Requirements of the Degree of B.Sc. (Honor) In Electronics Engineering

Prepared By:

- ARWA ALI MOHAMED ELTAHIR.
- HADEEL HAIDER AHMED ALSHIEKH.
- MAAB SIDDIG OSMAN HUSSEIN.
- MIHRAB IBRAHIM ADAM MOHAMED.

Supervised:

Dr. Ala Aldeen Awouda

September 2014

الاستهـــــــلال

قال تعالى:

(اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (*)
خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ (*) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ
(*) الَّذِي عَلَّمَ بِالْقَلَمِ (*)
عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ (*))

صدق الله العظيم

سورة العلق الآيات (1-5)

Dedication

We lovingly dedicate this thesis to:

Ourparent who supported us in each step of the way,

All friends who encourage and support us,

All teachers who teach us about life and light our ways with science,

All colleagues who are go with us in this journey and make it funny.

Acknowledgment

In the Name of Allah, the Most Merciful, the Most Compassionate all praise is to Allah, the Lord of the worlds; and prayers and peace be upon Mohamed his servant and messenger.

We are very grateful for our supervisor Dr.AlaAldeenAwoudawho worked hard with us from the begging until the completion of the researchand he has been always generous during all phases of the research.

We owe a deep debt of gratitude to our university for giving us an opportunity to complete this work.

We would like to take this opportunity to say warm thanks to all our beloved friends, who have been so supportive along the way of doing this thesis.

Last but not least, deepest thanks go to all people who took part in making this thesis real.

Abstract

Line follower robot is a robo-car that can follow a path. The path can be visible like a black line on the white surface (or vice-verse). It is designed to move automatically and follow the made plot line. The robot is using four light dependent resistance (LDR) sensors to identify the black line avoid the robot to steer away from its track .Robot is driven using dc servo motors to control the movement of the wheels. The atmega16 microcontroller will be used to perform PID algorithmsto control the speed of the servo motors steering the robot to travel along the line smoothly.

PID algorithms monitor and adjust the gain of robot used on the characteristic of the feedback, to improve robot performance .This concept can be applied for the an autonomous vehicle by applying the similar PID control method .PID control line following robot also can be modified into a guidance system for industrial robots that involving traveling in the building. Besidesthat, it also can apply in automated cars running on roads.

This project aims to implement the PID algorithm and control the movement of the robot by proper tuning of the control parameters and thus achieve better Performance.

المستخلص

الروبوت المتتبع للخط هو سيارة روبو يمكن أن تتبع المسار .الطريق يمكن أن يكون مرئي مثل خط أسود على السطح الأبيض (أو العكس).وهي مصممة للتحرك تلقائيا وتتبع الخط المرسوم . الروبورت يستخدم أربعة مقاومات حساسة للضوء للتعرف على الخط الأسود ليتجنب الروبوت الابتعاد عن مساره.يدفع الروبوت بإستخدام محركات التيار المستمرالمؤازرة (سيرفو) للتحكم في حركة العجلات. سيتم استخدام متحكم اتميقا 16 لأداء خوارزميات المتحكم التناسبي التكاملي التفاضلي للتحكم في سرعة المحركات المؤازرة لتوجيه الروبوت للسير على طول الخط بسلاسة.

خوارزميات المتحكم التناسبي التكاملي التفاضلي تراقب وتضبط كسب الروبوت المستخدم في سمة من ردود الفعل، من أجل تحسين أداء الروبوت.هذا المفهوم يمكن تطبيقه على مركبة ذاتية التحكم من خلال تطبيق أسلوب مماثل لتحكم المتحكم التناسبي التكاملي التفاضلي.أيضاالمتحكم التناسبي التكاملي التفاضلي للتحكم في خط سير الآلي أيضا يمكن تعديله ليكون نظامتوجيه للروبوتات الصناعية ويتضمن ذلك التحرك داخل المبنى.إلى جانب ذلك يمكن أن تطبق أيضا" في السيارات ذاتية التحكم على الطرقات .

ويهدف هذا المشروع إلى تنفيذ خوارزمية المتحكم التناسبي التكاملي التفاضليومراقبة حركة الروبوت من الضبطالصحيحلمعاملات التحكم وبالتالي تحقيق أفضل أداء.

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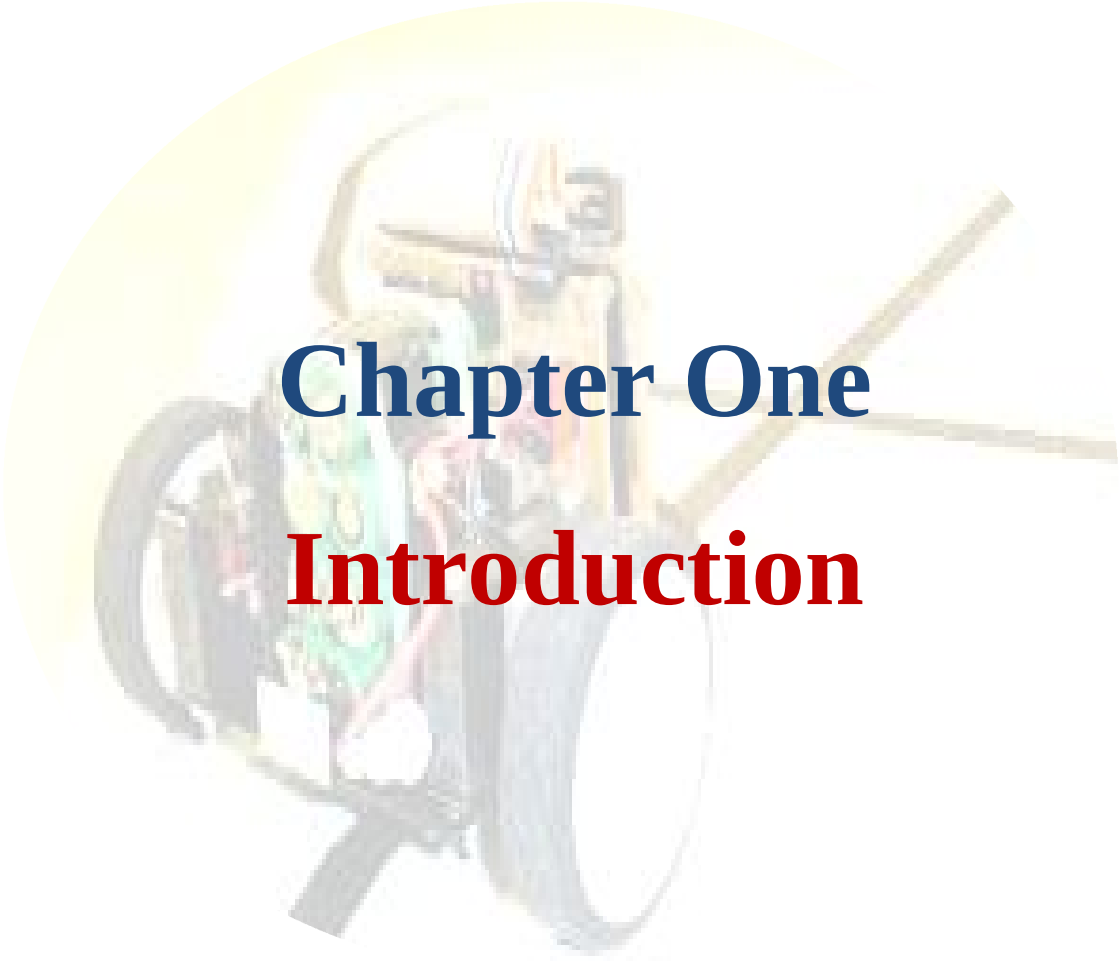
List of Abbreviations

AC	Alternating Current
ADC	Analog to Digital Converter
AVCC	Analog Voltage at a Common Connector
AVR	Alf and VergilRISC processor
CPU	Central Processing Unit
DAC	Digital to Analog Convertor
DC	Direct Current
EEPROM	Electrical Erased programmable Read Only Memory
FLC	Fuzzy Logic Controller
GND	Ground
IJARCET	International Journal of Advanced Research in Computer Engineering & Technology
IR	Infrared Red
LCD	liquid crystal Display
LDR	light dependent resistor
LED	light emitting diode
LFR	Line Follower Robot
MCLR	Master clear (circuitry)
OCR	Output Compare Register
P	Proportional.
PD	Proportional-derivative.
PI	proportional –integral
PID	proportional –integral -Derivative
RAM	Random Access Memory
RISC	Reduce Instruction Set
RUR	Rossum's Universal Robots
VCC	Voltage at a Common Connector
Vin	input voltage

Vout	output voltage
VREF	Reference Voltage
XTAl	Crystal

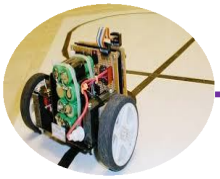
List of appendices

Appendix	Title
A	code
B	Atmega16 microcontroller datasheet
C	drive circuit datasheet



Chapter One

Introduction



1.1 Overview

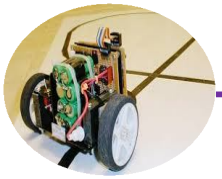
Word robot come from " robota " which means serf labor , KarelČapek was the first who used this word ,He is a Czech writer use word robot on one of his shows called R.U.R (Rossum's Universal Robots) in 1921 . Robot can be defined as a machine performs certain function, general machine requires an operator to perform its function, andhowever robots can be programmed to do it by themselves.

Generally robots have three main parts which include processor, sensor and motor controlsystem. Robot sensors represent eyes while actuators act as legs and controller acts as the brain of a human. Isaac Asimov created the three laws of robot behavior in 1940s. The Three Laws are:

"Law 1: A robot may not injure a human being or, through inaction, allow a human being to come to harm. Law 2:A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law3:A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws."(Anderson, 2008)[1]

Robot can replace human's job because it can perform faster than humans. Robots need not to drink, to be paid or rest as compared to humans. They can do repetitive work with high accuracy and will not stop or slow until the task is finished while humans get bored , robots can perform their job much faster and much accurately and delicate in comparison to humans.

Autonomous robots are the robots that can perform desired tasks in any environment without continuous human guidance. In fields like space exploration high degree of autonomy is required where communication and delays are unavoidable. In the real world a fully autonomous robot has the ability to gain information about the environments and to work for months without human



intervention. It can travel from one location to the other without navigation assistance. It can avoid situations that are harmful to any property or itself and can repair without external assistance.

1.2 Problem statement

In the industry carriers are required to carry products from one manufacturing Plant to another which are usually in different buildings or separate blocks. Conventionally, cars or trucks were used with human drivers. Unreliability and inefficiency in this part of the assembly line formed the weakest link. Classical line following robot is slow response to the error occur will easily leave its track that drawn on the floor. This problem will result the motion of the robot to be unsmooth and sometimes robot tends to move out of the track. Although the line following robot can follow the black line, its motion still needs to be improved.

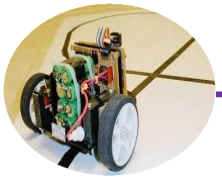
1.3 Proposed solution

A proposed robot that follows predefined path, instead of carts and trucks which are both costly and an inconvenience. A better controller is needed to make robot follow the line smoothly and make less error. The motion of line following robot can be improved by using feedback mechanism which forms an effective closed loop system. PID controller used as error correction method.

1.4 Objectives

The main objective is to design controller for the robot which tend to accurate line following process, to achieve this objectives:

1. A proposed control system will be used for line follower.
2. Simulation for proposed system will be run for design analysis.
3. Implement PID controller for proposed system.
4. Evaluate system performance.



1.5 Scope of study

This project focuses at designing and building a line follower robot and implements the PID controller. Two main areas were covered: Control area, it represented by microcontroller unit, andcontrol algorithm area represented by PID controller.

1.6 Methodology

The basic methodology contains three phases:

Phase 1: Preparing phase

Collect previous information about the line follower robot include components,applications, and line detection techniques and controlling method.

Phase 2: Design phase

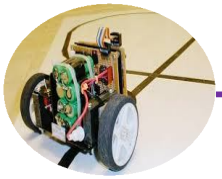
The design phase contain hardware and software design. Hardware design include design and construct platform which it contain atmega16 microcontroller chip, sensor circuit and driving mechanism. Software design include develop and compile program using Bascom,simulate the circuit using proteus, and download program into atmega16.

Phase 3: Testing and Development phase

Test and troubleshoot the hardware and tuning PI algorithm by adjust the software parameters for each factor to achieve better performance.

Finally, the robot will follow the black line drawn on the floor while smoothing tracking motion.

1.7 Thesis organization

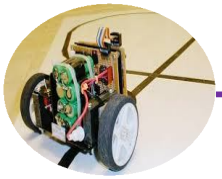


This thesis consists of six chapters. This chapter discusses overview of Project,research objective and aims, project scope, problem statement, proposed solution and thesis organization.

Chapter 2 contains literature review and system components.

Chapter 3includes Control Algorithm.

Chapter4includes System design.

Chapter 5 is about simulation and result.

Chapter 6 includes conclusion and Recommendations.