

# Line Follower Robot with PID Control

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**Abstract**— The Line Follower Robot Using PID Control with Register Level project was done using the STM32F103C8 coded microcontroller, at the Register Level and coded in C language. The purpose of the robot is to follow a very dark line drawn on a light background. The drawn path has sharp turns of 90 degrees, circular parts, and sudden turns of 30 or 45 degrees in different directions. In this way, it has become specific what kind of algorithms the sensor should have while reading. The second main aim of the project is for the robot to complete the drawn path (Figure 1.3) as soon as possible. The better the implementation of the PID Controller, the more stable the robot will be. This will ensure that the path is completed in a shorter time. Many tests and observations were made for P, I and D values, and the optimum values were reached by analyzing the robot's movements. In addition, it is possible to say that robots with different structures will have different P, I, D values due to the effect of the robot's hardware design on its weight. Since 4S RMS Li-Io Battery Pack is used in our project, it is possible to say that it is twice as heavy as its counterparts. For this reason, it has been observed that its stability decreases as it accelerates. Additionally, an extra feature has been added for the coding part. By considering the working principle of the sensors when they are not reading lines, the engines stop on normal ground and when they start reading lines, they continue reading the road quickly again. As a result, a robot has been developed that is stable in sharp turns, can stop in the absence of a line, and continues reading the road as soon as it detects the line.

**Keywords**— Line Follower Robot with PID Control, STM32F103C8 Microcontroller, C Programming Language, Infrared Sensor, Path Following, Stability, Li-Io Battery, RPM, QTR-SRC Infrared Line Tracking Sensor, ST-LINK/V2, L298N Motor Driver, Voltage Regulator, Mini Adjustable 3A Step-Down Voltage Regulator LM2596, Sensor Distance, ST-Link V2, Li-Ion Battery, RMS, PWM, Duty Cycle, Keil uVision5.

## I. INTRODUCTION

The aim of this designed project is to create a suitable control algorithm for the robotic vehicle to complete the predetermined track in as little time as possible. In this project, an infrared sensor was used for the line-following robot to follow the line on the specified track, and the movement of the robot was adjusted according to this sensor. Another purpose is to shut down the line-following robot to save power after 6 seconds when it cannot find a line. When the vehicle is placed on the road again, it will automatically activate and follow the road. A map algorithm has been developed for the designed PID-controlled line-following robot to detect and follow the specified path. It is aimed to complete the track in a stable state by minimizing the oscillation of the black line path created by debugging the errors of the data collected with the line tracking sensor with the PID control system and without leaving the track. The control method with a proportional-integral-derivative controller control loop is called PID control. PID control constantly and regularly calculates the error value and tries to return the system to the input value.

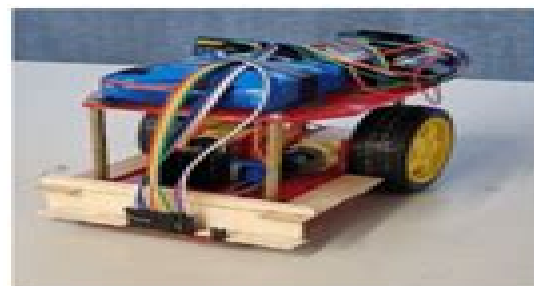


Figure 1: Line Follower Robot

## II. BUILDING LINE FOLLOWER ROBOT

### A. Mechanical Components

The line-following robot vehicle used and developed in the project can be seen. Two 6V DC motors with 250 RPM were used as motors in the project. Motors have 6-7V DC input voltage and 9V to the motor in the project. The fact that the motors are affordable and can reach high RPM values in a short time with high input voltage was effective in choosing these motors. Controlling the motors has an important place in following the drawn line and responding correctly to debugging the sensor. Motors have been added to the interior of the line following robot for an aesthetic appearance. Two wheels are fixed to the skeleton system so that they can rotate without skidding, and each is connected to its own engine. The wheels were chosen to reduce slipping so that the vehicle remains stable on the ground and does not skid during turns. The electronic and mechanical components are fixed to two pieces of plastic frame parts. While designing the vehicle, the QTR-SRC infrared line tracking sensor was desired to be close to the ground, so it was positioned with wide wooden tongue sticks. As a result of the experiments, the mechanical components were combined in the skeletal system and the design was completed (Figure 1).

### B. Electronic Components

1) *Microcontroller (STM32F103C8):* Microcontroller is the name given to integrated circuits that combine a microprocessor, memory and I/O pins within the integrated circuit. It is generally used in embedded systems. It is low cost and low power consumption. ARM-based STM32F103C8T6 microcontroller development board, also known as Blue Pill, was used in the project. With microcontroller, the sensor data

# Very Fast Line Follower Robot With Pid Control

**Miomir Vukobratovic, Dragan Stokic**



## **Very Fast Line Follower Robot With Pid Control:**

**Industrial Networks and Intelligent Systems** Nguyen-Son Vo, Hoai-An Tran, 2023-10-30 This book constitutes the refereed proceedings of the 9th EAI International Conference on Industrial Networks and Intelligent Systems INISCOM 2023 held in Ho Chi Minh City Vietnam during August 2 3 2023 The 23 full papers were selected from 55 submissions and are organized thematically in tracks on telecommunications systems and networks information processing and data analysis industrial networks and intelligent systems security and privacy *Intelligent Technologies: Design and Applications for Society* Vladimir Robles-Bykbaev, Josefa Mula, Gilberto Reynoso-Meza, 2023-01-31 This book is oriented towards applications and perspectives on future developments connected to intelligent technologies Specifying topics connected to industry mobility telecommunications biomechanics among others The innovative character of the text allows relating technical experiences and advances that seek to improve the implication of new technologies at local national and regional levels demonstrating the advances towards the different fields of knowledge in the area of engineering The potential readers of this work would be master and doctorate students professors researchers in the field of new technologies and companies connected to the development of engineering The texts serve to illustrate new procedures new cases and new techniques for the optimization of systems that optimize social progress **Proceedings of the National Conference on Advanced Manufacturing & Robotics, January 10-11, 2004** S. N. Shome, Jhankar Basu, G. P. Sinha, 2004 Contributed papers presented at the conference held at Central Mechanical Engineering Research Institute Durgapur *Robot Control 1991 (SYROCO'91)* I. Troch, 2014-05-23 This volume contains 92 papers on the state of the art in robotics research In this volume topics on modelling and identification are treated first as they build the basis for practically all control aspects Then the most basic control tasks are discussed i e problems of inverse kinematics Groups of papers follow which deal with various advanced control aspects They range from rather general methods to more specialized topics such as force control and control of hydraulic robots The problem of path planning is addressed and strategies for robots with one arm for mobile robots and for multiple arm robots are presented Also covered are computational improvements and software tools for simulation and control the integration of sensors and sensor signals in robot control Learning LEGO MINDSTORMS EV3 Gary Garber, 2015-01-27 This book is for the hobbyists builders and programmers who want to build and control their very own robots beyond the capabilities provided with the LEGO EV3 kit You will need the LEGO MINDSTORMS EV3 kit for this book The book is compatible with both the Home Edition and the Educational Edition of the kit You should already have a rudimentary knowledge of general programming concepts and will need to have gone through the basic introductory material provided by the official LEGO EV3 tutorials *Proceedings of SAI Intelligent Systems Conference (IntelliSys) 2016* Yaxin Bi, Supriya Kapoor, Rahul Bhatia, 2017-08-22 These proceedings of the SAI Intelligent Systems Conference 2016 IntelliSys 2016 offer a remarkable collection of papers on a wide range of topics in intelligent systems and their applications to the real

world Authors hailing from 56 countries on 5 continents submitted 404 papers to the conference attesting to the global importance of the conference s themes After being reviewed 222 papers were accepted for presentation and 168 were ultimately selected for these proceedings Each has been reviewed on the basis of its originality novelty and rigorousness The papers not only present state of the art methods and valuable experience from researchers in the related research areas they also outline the field s future development

**Adaptive Control for Robotic Manipulators** Dan Zhang,Bin Wei,2017-02-03 The robotic mechanism and its controller make a complete system As the robotic mechanism is reconfigured the control system has to be adapted accordingly The need for the reconfiguration usually arises from the changing functional requirements This book will focus on the adaptive control of robotic manipulators to address the changed conditions The aim of the book is to summarise and introduce the state of the art technologies in the field of adaptive control of robotic manipulators in order to improve the methodologies on the adaptive control of robotic manipulators Advances made in the past decades are described in the book including adaptive control theories and design and application of adaptive control to robotic manipulators

**PID Control** Tamer Mansour,2011-04-19 The PID controller is considered the most widely used controller It has numerous applications varying from industrial to home appliances This book is an outcome of contributions and inspirations from many researchers in the field of PID control The book consists of two parts the first is related to the implementation of PID control in various applications whilst the second part concentrates on the tuning of PID control to get best performance We hope that this book can be a valuable aid for new research in the field of PID control in addition to stimulating the research in the area of PID control toward better utilization in our life

Robots Manipulators John X. Liu,2005 This book deals with control and learning in robotic systems

**Artificial Intelligence and Soft Computing, Part II** Leszek Rutkowski,Rafał Scherer,Ryszard Tadeusiewicz,Lotfi A. Zadeh,Jacek M. Zurada,2010-06 This volume constitutes the proceedings of the 10th International Conference on Artificial Intelligence and Soft Computing ICAISC 2010 held in Zakopane Poland in June 13 17 2010 The articles are organized in topical sections on Fuzzy Systems and Their Applications Data Mining Classification and Forecasting Image and Speech Analysis Bioinformatics and Medical Applications Volume 6113 together with Neural Networks and Their Applications Evolutionary Algorithms and Their Applications Agent System Robotics and Control Various Problems aof Artificial Intelligence Volume 6114

**Applied Control** S. G. Tzafestas,1993-04-29 This book provides a representative set of modern methodologies and applications including new topics in the field discussing a wide range of issues and treating them in depth The book describes analytical processes for fault diagnosis of automatic control systems examines modern sensors and actuators as well as measurement techniques considers multidimensional feedback control and image restoration procedures among other topics

**Robot Control 1988 (SYROCO'88)** U. Rembold,2014-05-23 Containing 88 papers the emphasis of this volume is on the control of advanced robots These robots may be self contained or part of a system The applications of such robots vary from manufacturing

assembly and material handling to space work and rescue operations Topics presented at the Symposium included sensors and robot vision systems as well as the planning and control of robot actions Main topics covered include the design of control systems and their implementation advanced sensors and multisensor systems explicit robot programming implicit task orientated robot programming interaction between programming and control systems simulation as a programming aid AI techniques for advanced robot systems and autonomous robots

**Mastering Robot dynamics** Cybellium, Embark on an Enlightening Journey to Mastering Robot Dynamics In a world driven by automation and robotics mastering the intricacies of robot dynamics is pivotal for creating advanced robotic systems that move with precision and intelligence Mastering Robot Dynamics is your ultimate guide to navigating the complex world of robot motion control and manipulation Whether you re an engineer researcher robotics enthusiast or student this book equips you with the knowledge and skills needed to excel in designing and controlling sophisticated robotic mechanisms About the Book Mastering Robot Dynamics takes you on a transformative journey through the intricacies of robot motion and control from foundational concepts to advanced techniques From kinematics and dynamics to trajectory planning and real time control this book covers it all Each chapter is meticulously designed to provide both a deep understanding of the principles and practical applications in real world robotic scenarios Key Features Foundational Understanding Build a solid foundation by comprehending the core principles of robot dynamics including kinematics inertia and motion equations Robot Kinematics Explore forward and inverse kinematics understanding how robots move and calculating joint configurations Robot Dynamics Dive into the study of forces torques and motion equations learning how robots interact with their environments Trajectory Planning Master the art of planning robot paths and trajectories considering constraints and optimizing motion sequences Sensors and Perception Gain insights into sensor integration perception systems and how robots interact with the world through feedback Motion Control Learn about different types of control strategies from PID control to advanced techniques like model predictive control Collision Avoidance Understand methods for detecting and avoiding collisions ensuring safety and reliability in robot operations Robot Manipulation Explore techniques for manipulating objects including grasp planning manipulation tasks and robotic arms Challenges and Trends Discover challenges in robot dynamics from sensor noise to complex control algorithms and explore emerging trends shaping the future of robotics Who This Book Is For Mastering Robot Dynamics is designed for engineers researchers robotics enthusiasts students and anyone passionate about robotics Whether you re aiming to enhance your skills or embark on a journey toward becoming a robotics expert this book provides the insights and tools to navigate the complexities of designing and controlling robotic systems 2023 Cybellium Ltd All rights reserved [www.cybellium.com](http://www.cybellium.com)

*Advances in Robot Design and Intelligent Control* Aleksandar Rodić, Theodor Borangiu, 2016-11-26 This book presents the proceedings of the 25th International Conference on Robotics in Alpe Adria Danube Region RAAD 2016 held in Belgrade Serbia on June 30th July 2nd 2016 In keeping with the tradition of the event RAAD 2016 covered all the important areas of

research and innovation in new robot designs and intelligent robot control with papers including Intelligent robot motion control Robot vision and sensory processing Novel design of robot manipulators and grippers Robot applications in manufacturing and services Autonomous systems humanoid and walking robots Human robot interaction and collaboration Cognitive robots and emotional intelligence Medical human assistive robots and prosthetic design Robots in construction and arts and Evolution education legal and social issues of robotics For the first time in RAAD history the themes cloud robots legal and ethical issues in robotics as well as robots in arts were included in the technical program The book is a valuable resource for researchers in fields of robotics engineers who implement robotic solutions in manufacturing services and healthcare and master s and Ph D students working on robotics projects

*Dynamic Neural Networks for Robot Systems: Data-Driven and Model-Based Applications* Long Jin, Predrag S. Stanimirovic, Sendren Sheng-Dong Xu, 2024-07-24 Neural network control has been a research hotspot in academic fields due to the strong ability of computation One of its widely applied fields is robotics In recent years plenty of researchers have devised different types of dynamic neural network DNN to address complex control issues in robotics fields in reality Redundant manipulators are no doubt indispensable devices in industrial production There are various works on the redundancy resolution of redundant manipulators in performing a given task with the manipulator model information known However it becomes knotty for researchers to precisely control redundant manipulators with unknown model to complete a cyclic motion generation CMG task to some extent It is worthwhile to investigate the data driven scheme and the corresponding novel dynamic neural network DNN which exploits learning and control simultaneously Therefore it is of great significance to further research the special control features and solve challenging issues to improve control performance from several perspectives such as accuracy robustness and solving speed

*Robot Manipulators* Alex Lazinica, Hiroyuki Kawai, 2010-04-01 Robot manipulators are developing more in the direction of industrial robots than of human workers Recently the applications of robot manipulators are spreading their focus for example Da Vinci as a medical robot ASIMO as a humanoid robot and so on There are many research topics within the field of robot manipulators e g motion planning cooperation with a human and fusion with external sensors like vision haptic and force etc Moreover these include both technical problems in the industry and theoretical problems in the academic fields This book is a collection of papers presenting the latest research issues from around the world

**Proceedings, IEEE International Symposium on Intelligent Control**, 1996 *Advances in Natural Computation* Lipo Wang, Ke Chen, Yew Soon Ong, 2005-08-25 This book and its sister volumes i e LNCS vols 3610 3611 and 3612 are the proceedings of the 1st International Conference on Natural Computation ICNC 2005 jointly held with the 2nd International Conference on Fuzzy Systems and Knowledge Discovery FSKD 2005 LNAI vols 3613 and 3614 from 27 to 29 August 2005 in Changsha Hunan China

**Intelligent and Fuzzy Techniques in Big Data Analytics and Decision Making** Cengiz Kahraman, Selcuk Cebi, Sezi Cevik Onar, Basar Oztaysi, A. Cagri Tolga, Irem Ucal Sari, 2019-07-05 This book includes the

proceedings of the Intelligent and Fuzzy Techniques INFUS 2019 Conference held in Istanbul Turkey on July 23 25 2019 Big data analytics refers to the strategy of analyzing large volumes of data or big data gathered from a wide variety of sources including social networks videos digital images sensors and sales transaction records Big data analytics allows data scientists and various other users to evaluate large volumes of transaction data and other data sources that traditional business systems would be unable to tackle Data driven and knowledge driven approaches and techniques have been widely used in intelligent decision making and they are increasingly attracting attention due to their importance and effectiveness in addressing uncertainty and incompleteness INFUS 2019 focused on intelligent and fuzzy systems with applications in big data analytics and decision making providing an international forum that brought together those actively involved in areas of interest to data science and knowledge engineering These proceeding feature about 150 peer reviewed papers from countries such as China Iran Turkey Malaysia India USA Spain France Poland Mexico Bulgaria Algeria Pakistan Australia Lebanon and Czech Republic

*Applied Control of Manipulation Robots* Miomir Vukobratovic, Dragan Stokic, 2012-12-06

The first book of the new textbook series entitled *Applied Dynamics of Manipulation Robots Modelling Analysis and Examples* by M Vukobratovic published by Springer Verlag 1989 was devoted to the problems of dynamic models and dynamic analysis of robots The present book the second in the series is concerned with the problems of the robot control In conceiving this textbook several dilemmas arouse The main issue was the question on what should be incorporated in a textbook on such a complex subject Namely the robot control comprises a wide range of topics related to various aspects of robotics starting from the synthesis of the lowest executive control level through the synthesis of trajectories which is mainly related to kinematic models of robots and various algorithms for solving the problem of task and robot motion planning including the solving of the problems by the methods of artificial intelligence to the aspects of processing the data obtained from sensors The robot control is closely related to the robot programming i.e. the development of highly specialized programming languages for robot programming Besides numerous aspects of the control realization should be included here It is obvious that all these aspects of control cannot be treated in detail in the frame of a text book

## Unveiling the Magic of Words: A Review of "**Very Fast Line Follower Robot With Pid Control**"

In a global defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is actually awe-inspiring. Enter the realm of "**Very Fast Line Follower Robot With Pid Control**," a mesmerizing literary masterpiece penned with a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve in to the book is central themes, examine its distinctive writing style, and assess its profound effect on the souls of its readers.

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