

الآية

قال الله تعالى:

بسم الله الرحمن الرحيم

في جَلْقِ السَّمَوَاتِ وَالْأَرْضِ وَاخْتِلَافِ الدَّيْلِ وَالنَّهَارِ لآيَاتٍ لِأُولِي الْأَلْبَابِ الَّذِينَ يَذْكُرُونَ اللَّهَ قِيَامًا
وَقُعُودًا وَعَلَى جُنُوبِهِمْ وَيَتَفَكَّرُونَ فِي خَلْقِ السَّمَوَاتِ وَالْأَرْضِ رَبَّنَا مَا خَلَقْتَ هَذَا بَطْلًا تُسَبِّحُكَ فَقَدْنَا
عَذَابَ النَّارِ {

صدق الله العظيم

سورة آل عمران الآية (190-191)

DEDICATION

To my beloved,

parents "Mohamed Elfatih and Fawzia Nadeem", wife and son "Safa and Ahmed", and brothers "Walla and Wail", whom always stand behind me, and gave me ability and strength to proceed on this work. Their love and affection help me stand where I am. To all of those encouraged me to carry out this work

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ABSTRACT

This thesis presents derivation of a trajectory tracking and posture stabilizing controller for a differentially-driven Wheeled Mobile Robot (WMR). The robot vehicle is a sturdy platform actuated by Direct Current (DC) motors capable of steering the WMR in different trajectories. For trajectory tracking, an essential capability for autonomous operation, a reliable and robust controller is needed. In addition, as the WMR-vehicle is unstable while moving, the controller is required to stabilize it during trajectory tracking process. The robot vehicle is modeled with three Degrees Of Freedom (3DOF) rigid body equations and an efficient control algorithm, called Lypaunov function direct method, is used to tackle the challenges posed by nonlinearities of the model. The main contribution of this work is analysis of 3DOF physical model and a consolidated stable control law for tracking and posture stabilizing of the mobile robot. Simulation results show the effectiveness of the controller. In addition, the proposed trajectory tracking controller has been benchmarked with the well-known Kanayama's controller. Further, several motion tasks are performed in order to examine the new controller motion capabilities, and the ability of carrying out motion with different trajectories shapes.

مستخلص

تقدم هذه الأطروحة نموذج لتصميم وحدة التحكم في تتبع المسار و استقرارية الوضع للروبوت المتحرك بعجلات. الروبوت المتحرك بعجلات يتكون من منصة قوية تدفعها محركات للتيار المباشر و التي لها القدرة علي توجيهه في مختلف المسارات. الحاجة لوحدة تحكم موثوقة و قوية في العمليات المستقلة (الآلية) أمر ضروري و ذلك لأغراض الحركة و تتبع المسار, كما هو الحال في استخدام الروبوت ذو العجلات. علاوة علي ذلك, فان المتحكمه تعمل علي استقرارية الوضع لهيكل الروبوت نتيجة لعدم الاستقرارية الذي تنشأ اثناء عملية تتبع المسارات المختلفة. تم اشتقاق النموذج الحركي لهيكل الروبوت بثلاثة درجات حرية من معادلات الجسم الصلب, و من ثم استخدمت خوارزمية التحكم (دالة ليبونوف المباشرة) لمعالجة التحديات التي تشكلها الاخطية في النموذج الحركي. تساهم هذه الأطروحة بتحليل النموذج الفيزيائي للروبوت المحمول مع ثلاثة درجات حرية, بالإضافة الي تصميم وحدة تحكم موحدة لتتبع المسار و استقرار الوضع. تمت نمذجة و محاكاة نظام تحكم الحلقة المغلقة للروبوت المحمول في بيئة MATLAB/SIMULINK, وأثبتت النتائج فعالية وحدة التحكم المصممة. إضافة الي ذلك, تمت مقارنة وحدة التحكم المقترحة مع وحدة تحكم مستقرة لتتبع المسار و استقرار الوضع, والتي طورت في السابق من قبل (كاناياما). علاوة علي ذلك, تم محاكاة العديد من المهام الحركية من اجل فحص مقدرة وحدة التحكم المقترحة و امكانية تنفيذ المهام لعدد من المسارات المختلفة بأشكال بسيطة و معقدة نسبياً.

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LIST OF ABBREVIATIONS

ASM

Active Set Model

DC	Direct Current
DOF	Degrees Of Freedom
FBFN	Fuzzy Basis Function Network
FL-ASM	Fletcher's Active Set Method
MDOF	Multi-Degree of Freedom
MPC	Model Predictive Control
N-WMR	Nonholonomic-Wheeled Mobile Robot
NF-ASM	Non-feasible Active Set Model
PD	Proportional–Derivative
PI	Proportional–Integral
PID	Proportional–Integral–Derivative
PWM	Pulse Width Modulation
WMR	Wheeled Mobile Robot

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