DESIGN OF CONTROL SYSTEM FOR AUTOMATIC STEERING

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'I/we* admit to have read this report and it has followed the scope and quality in partial fulfilment of requirement for the Degree of Bachelor of Mechanical Engineering (Automotive)'

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This Report Is Written As Partial Fulfillment of Terms in Achieving the Award for Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering

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"I admit that this report is from my own work and idea except for the summary and a few sections which were extracted from other resources as being mention".

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To my lovely parents, my brother and sister who give me encouragement to success in my studies and not to forget special thanks to all my lecturers and friends that give me guideline and support during my study in UTeM

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ABSTRAK

Perubahan sistem stereng konvensional kepada sistem stereng automatik membuka ruang untuk mempertingkatkan keselamatan kenderaan dan ciri-ciri pengawalan kenderaan. Projek ini menerangkan rekabentuk sistem kawalan untuk stereng automatik di mana sistem dibangunkan dari stereng konvensional gear kepada system stereng automatik. Pembinaan sistem stereng automatik ini dengan pemilihan konsep rekabentuk rangka ujian sementara yang akan digunakan dalam projek ini. Skor metrik untuk konsep-konsep rekabentuk kerangka ujian sementara dibuat untuk memilih rekabentuk terbaik yang akan dipindahkan dalam lukisan lengkap menggunakan perisian CATIA V5R16. Keputusan analisis menggunakan perisian CATIA menunjukkan rekabentuk kerangka ujian sementara sesuai dan boleh di gunakan untuk menyokong komponen-komponen sistem stereng. Nilai daya kilasan maksimum menetukan motor elektrik yang akan digunakan dalam eksperimen ini. Oleh itu, meter pengukur daya kilasan digunakan untuk mengukur daya kilasan stereng gear menggunakan kereta sebenar untuk menerapkan keadaan sebenar di dalam eksperimen. Pembinaan model simulasi sistem kawalan dalam stereng automatik di dalam MATLAB terdiri dari model *rack* dan *pinion* di mana hubungannya dengan sudut roda depan dilakukan eksperimen simulasi bahan dalam linkungan. Aplikasi alat penerima variasi gelombang digunakan untuk mencari hubungan antara roda stereng dengan roda beban yang juga dikenali nisbah stereng. Motor langkah menunjukkan prestasi baik dengan memberi respon kurang dari dua saat yang mengikuti prestasi kriteria motor yang baik.Keputusan akhir kajian menunjukkan model simulasi stereng automatic yang dibangunkan adalah sah dengan membuat perbandingan dengan eksperimen simulasi alat dalam lingkaran.

ABSTRACT

The conversions of conventional steering system to the Automatic steering system give the opportunities to the vehicle handling characteristic improvement and also improvement on the safety of the vehicle. This project presents the design of control system for automatic steering where the system is developed from the conventional rack-and-pinion to the Automatic steering system. The development of Automatic steering begins with the conceptual design selection on the test rig will be used in this project. Scoring metric on the various concept design of test rig has been performed for choosing the best design to be translated in detail design using MSC CATIA V5R16 software. Analyzing result from CATIA Analysis on the detailed design shows the rig suitable and available to support the steering system components. The maximum torque value at the rack-and-pinion determines the electric motor that will be used in the experiment. Thus, torque meter is used and it is tested in the typical vehicle due to adopt the real car condition in the experiment. The developments of inner-loop controller simulation model of automatic steering in MATLAB consist of the rack-and-pinion model where the relationship between rack-and-pinion displacement and road wheel angle is determined in the HILS experiment. Therefore the transducer application is applied on the steering system to find the relationship. The stepper motor determined a good performance in the position tracking where it achieved the desired output less than the 2 s which is followed the good performance criteria. The results obtained show the developed inner-loop controller models of automatic steering is valid by comparing with the Hardware-in-the-loop-simulation (HILS) experiment.

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b	=	Rack displacement, m
c	=	Cos
h	=	Distance of Wheel Axis to the Rack Axis, m
k	=	unknown
s	=	Sin
l_1	=	Length of right kingpin, m
l_2	=	Length of Tie Rod, m
z_1	=	Unknown
θ_1	=	Front wheel Steer Angle, deg
HILS	=	Hardware-in-the-loop-simulation

APPENDIX

CHAPTER 1

INTRODUCTION

1.0 Background

The purpose of this project report is to develop the design of control system for Automatic Steering. Steering system functions as to turn the front wheel using the steering wheel which has the universal joint to allow it deviate from the straight line. The two most common steering systems used today are rack-and-pinion (cars, small trucks, and SUVs) and the re-circulating ball system (trucks and SUVs). As the technology of steering is explored the systems changing from the conventional rack-and pinion to rack-and-pinion with hydraulic assist which is known as power steering and the systems improved to electric power steering.

The improvement of steering system due to improvements of the steering efficiency, fuel efficiency, safety and power reduces. Although the steering system have improved there are still have inefficiency where the steering column count as a major source for injury to the driver for the front-end collision. Therefore, a further development has been taken to develop steering system which the mechanical connection placed between the steering wheel and rack is replaced with a purely electronics control system which known as Automatic Steering system.

Automatic steering system contains electric motor actuators and various integrated sensor experiencing the same role as the mechanical steering system linkages. The sensors interpret the choosing to do and also read the feedback that is sent from the controller. It benefits the owner of vehicle. The elimination of steering column and steering wheel increases in the passive safety performance and also create production benefit due to simplify the interior design of the vehicle.

1.2 Problem statement

Most of modern car steering systems which are included the mechanical linkages contribute to the number of frontal crash accident due to existing of steering shaft. The current modern cars also have the fixed steering ratio characteristic which cannot be changed according to the driving condition therefore the stability of the car cannot be changed and cause the car in unstable condition and generate yaw moment to the car. The factor make me to choose this project, with converting to the Automatic Steering system the cases above would be reduced without existing steering column and steering wheel and also the steering ratio could be change depends on the vehicle condition.

1.3 Objective

1. To develop Automatic steering system test rig conceptual design and detail design

2. To compute the rack-and pinion torque value in hanging and touching to ground condition

3. To determine the relationship between rack displacement and pinion angle and road wheel angle

4. To develop inner-loop controller of Automatic Steering System

5. To determine the performance position tracking of the Stepper Motor

1.4 Scope

1. The development of Conceptual design of Automatic steering system test rig with various sketch designs and development of detail design of steer by wire test rig by using MSC CATIA V5R16 software along with analysis.
2. The torque value is compute by using torque meter
3. Determination of relationship between rack-and-pinion displacement and road wheel angle using the TR1 Accu-Coder and Linear Variable Displacement Transducer (LVDT)
4. The inner loop controller of automatic steering develops by using Matlab-SIMULINK software.
5. The performance of the stepper motor position tracking is determined by the simulation and experiment.