MECHANISM DESIGN OF ACTIVE GEOMETRY CONTROL SUSPENSION SYSTEM

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Date : 24 May 2010

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This technical report is submitted in accordance with the requirements of the Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering
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MAY 2010

DECLARATION

"I hereby, declare this thesis entitled Mechanism Design of Active Geometry Control Suspension System is the result of my own research except as cited in the reference"

Signature : ……
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Date : 24 MAY 2010

DEDICATION

To my beloved family especially my father,
Abdul Latib Bin Abdullah
And also to my beloved mother,
Noriah Binti Shaari
Who keep me continuously motivated with their great support and encouragement through out my Bachelor Degree program

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ABSTRACT

This research is concerned on the effect of varying the toe angle and camber angle on the wheel of the Active Geometry Control Suspension (AGCS) system. AGCS system is one of conventional suspension system which the system is based on the ride handling performance of the vehicle. In this report, it will vary the toe and camber angle of the wheel in the McPherson Strut or Double Wishbone suspension system. In order to determine the effect of adjusting the toe and camber angle, it can be tested on the software called CarSim. Much type of data or parameters can be inserting into the software in term to get the result that wanted. As the project experiment, the range of data of toe and camber angle are taken to insert into the software and will be tested and simulate. After gaining the result from the software, it can be conclude either to change the toe and camber angle. Therefore to practical the varying the effect of toe and camber angle, the conceptual design is created and each of design is evaluate by the scoring method. After considering the entire criterion, the best conceptual design is choose for report. There is also some detailed design for the best conceptual design due to explain more towards the important components use in the mechanism. This design also undergoes with the structural analysis due to test the strength of the structure. As the result, it can determine the best design for the suspension system.

ABSTRAK

Kajian ini mementingkan dan meliputi perkara mengenai kesan terhadap pengubahsuai sudut kamber dan sudut toe ke atas roda di dalam Sistem Gantungan Kawalan Geometri Aktif.Sistem Gantungan Kawalan Geometri Aktif adalah salah satu sistem gantungan kesesuaian di mane sistem ini berdasarkan pretasi kawalan memandu ke atas kenderaan.Sistem ini mengawalkesan terhadap keadaan kenderaan dan menyebabkan sistem kenderaan stabil.Di dalam laporan ini,perubahan sudut toe dan sudut kamber ke atas roda sama dipraktikkan di dalam sistem gantungan McPherson atau sistem gantungan tulang selangka berganda.Bagi menentukan kesan perubahan sudut kamber dan sudut toe,ia boleh diuji dengan perisian yg dipanggil CarSim.Pelbagai data dan parameter boleh dimasukkan ke dalam perisian tersebut untuk mendapatkan keputusan yang dikehendaki.Bagi uji kaji yang dijalankan di dalam laporan ini,data ditentukan untuk disimpan ke dalam perisian bagi mendapatkan simulasi yg sesuai.Setelah mendapat keputusan daripada perisian,ianya boleh menentukan sama ada untuk mengubah sudut toe dan sudut kamber.Oleh itu beberapa konsep rekaan telah disediakan bagi menentukan rekaan terbaik yang akan digunakan untuk laporan nanti.Konsep rekaan yang telah dihasilkan akan dinilai dari segi criteria yang ditetapkan di dalam kaedah skor.Selepas mengambil kira penilaian terhadap kaedah skor,satu rekaan yang terbaik akan dipilih.Disamping itu,terdapat juga penerangan yang lebih terperinci mengenai konsep rekaan yang dipilih bagi memberitahu dan menerangkan komponen penting di dalam mekanisme tersebut. Rekabentuk ini juga mengalami dengan analisis struktural kerana untuk menguji kekuatan struktur. Akibatnya, dapat menentukan rekabentuk terbaik untuk sistem suspensi.

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NOMENCLATURE

AGCS	=	Active Geometry Control Suspension
CATIA	=	Computer Aided Tridimensional Application
ECU	=	Electronic Control Unite
4WS	=	Four Wheel Steering
CarSim	=	Car Simulation
ADAMS	=	Multibody Dynamics
MATLAB	=	Matrix Laboratory
Fzfl	=	Tire vertical force at front left wheel
Fzfr	=	Tire vertical force at front right wheel
Fzrl	=	Tire vertical force at rear left wheel
Fzrr	=	Tire vertical force at rear right wheel
Fyfl	=	Tire lateral force at front left wheel
Fyfr	=	Tire lateral force at front right wheel
Fyrl	=	Tire vertical force at front rear left wheel
Fyrr	=	Tire vertical force at front rear right wheel
Mb	=	Total vehicle mass
Ms	=	Total sprung mass
tf	=	Rear track width
tr	=	Front track width
l	=	Total wheelbase
b	=	Distance of vehicle C.G from front axle

c	=	Distance of vehicle C.G from rear axle
h	=	the height of vehicle C.G from the ground
v_x	=	Vehicle longitudinal speed
J_{sy}	=	Pitch moment of inertia
J_{sx}	=	Roll moment of inertia
J_z	=	Yaw moment of inertia
g	=	Gravitational acceleration
$\kappa\varphi$	=	Roll damping constant
$\kappa\theta$	=	Pitch damping constant
$\beta\varphi$	=	Roll stiffness constant
$\beta\theta$	=	Pitch stiffness constant
V_x	=	Longitudinal speed
V_y	=	Lateral speed
$\dot{V}_x$	=	Longitudinal acceleration
$\dot{V}_y$	=	Lateral acceleration
γ	=	Yaw rate
$\dot{\gamma}$	=	Yaw acceleration
I_z	=	Inertia in yaw direction
δ_f	=	Steer angle
C_f	=	Cornering stiffness of front tires
C_r	=	Cornering stiffness of rear tires
α_f	=	Front wheel side slip angle
αr	=	Rear wheel side slip angle

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Nowadays, the vehicle stability has been studied with intend to development of high-power vehicles. For example, the automotive industry have been introduced the 4WS (4 Wheel Steering) system which is develop the high-speed cornering performance by adjusting a front and rear wheel steer angle. Four-wheel steering is a system introduce by some vehicles to improve steering response, increase vehicle stability while cornering at high speed, or to decrease turning radius at low speed. However, 4WS components are very complicated and expensive because it requires much power in controlling the system.

Therefore, the automobiles industry has offering Active Geometry Control Suspension (AGCS) characteristics to overcome the problem. AGCS is an active device whose objective is to improve vehicle response by modifying the level of toe angle or camber angle variation of the rear or front suspension. (www.wikipedia.com)

The AGCS system is the effective method for the conventional suspension system to determine the stability of the vehicle. The AGCS system is been tested on the double wishbone suspension which some modification of the mechanism have been done to the upper arm of the front suspension. There are some analysis been done using the CARSIM software to determine which adjustment of the camber angle or toe angle

can decrease the height of the centre of the gravity. If the centre of the gravity of vehicle is low, the vehicle stability will increase while cornering .Its means that with AGCS system, the performance of the vehicle can increase. In order to have better ride handling performance, a mechanism have been created to modify the suspension system.

1.2 Problem Statement

The purpose of the report is to varying the effect of the toe and camber angle on the front wheel .Then, to determine the performance of the vehicle after the changes of the toe and camber angle. Moreover, it is intended to perform the conceptual design due to choose the best design for the report and to understand the operation and system of the Active Geometry Control suspension (AGCS).

1.3 Objectives

The objective is to study the effect of changing the toe and camber angel for the front suspension and to design mechanism that related to the AGCS system.

1.4 Scope

The scope of the project is to investigate on the performance of changing the toe and camber angle of the front suspension system. Then, create and design the 3D detailed design using CATIA V5R16 software. Then designed model using MATLAB to determine the tire forced. Calculate force on the suspension using ADAMS software. Finally, structural analysis been done to the design,

CHAPTER II

LITERATURE REVIEW

2.1 Active Geometry Control Suspension System Concepts

Active Geometry Control Suspension System (AGCS) is one of the mechanism that determine the vehicle stability while cornering .The AGCS system is a device to that will varying the toe angle, camber angle and roll center of the wheel by controlling the position of a front or rear suspension link. The system consists of actuator or motor as power source of the device. The AGCS is installed in the suspension either in the Macpherson strut suspension or the double wishbone suspension. For the MacPherson strut suspension, it been installed in the bottom of the suspension at the lower arm. Then, for the double wishbone suspension, it will install above the suspension at the upper arm. (Lee,S. 2005)

The systems involve with actuators, control lever and Electric Control Unit (ECU) as shown in Figure 2.1. ECU is adjusting actuator stroke based on the vehicle speed and steering angle. Then the control lever is rotating downward or upward around hinge. It moves the inboard mounting point of the rear wheel assist link to maintain optimal bump toe-in value. (Lee,S. 2005)

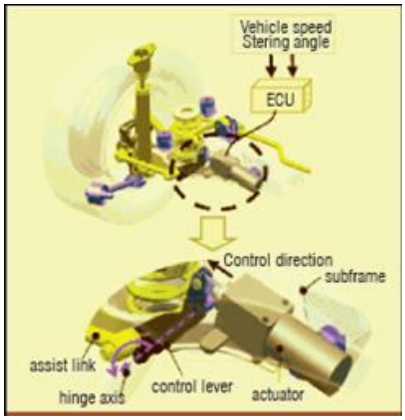

Figure 2.1: AGCS system layout (Lee,S. 2005)

In this system it consists of sensor part such as vehicle speed sensor and steering angle sensor. Vehicle speed sensor reads the vehicle speed and the steering angle sensor reads the driver steering amount. Control part commands the actuator by estimating lateral acceleration acting on the vehicle based on the data from the vehicle speed sensor and the steering angle sensor. (Lee,S. 2005)

The concept of AGCS is intelligent and it overcomes many negative points of conventional active suspension systems. AGCS has simple control logic and hardware component. Moreover, if energy supply goes off in conventional system the performance becomes failure mode but in AGCS, vehicle performance will be equal to passive suspension. (Lee,S. 2005)

In the AGCS system, it will estimates lateral acceleration acting on the vehicle based on the data from vehicle speed sensor and steering angle sensor. Based on the estimated lateral acceleration, it moves the actuator to increase rear outside. Since abrupt steering at high speed produces large centrifugal force on the vehicle, the rear part of the vehicle slips outward.