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STEERING SPEED SUSPENSION DEVICE (TRIPLE "S" DEVICE), TO PREVENT BURNOUTS –TAFHEET PHENOMENA

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ABSTRACT

In many Arab countries, young's tend to drive in uncivilized manner. One of those manners is driving on a very high speed and changing the direction by suddenly turning the steering achieving kind of fun and entertainment. This kind of hobbies in the Arab world is well known as "Tafheet", which almost leads to very disastrous results on the drivers, watchers and people who may be in the region. In the Arab Gulf countries, Tafheet phenomenon causes a social permanent worry, despite all the government rules, instructions and even penalties.

"Tafheet" phenomenon could be avoided kind of limiting the ability of steering system to make severe turn on high speed driving, with reversal proportional between the speed and the ability for sever turn, which is the main objective for this paper. The paper presents designing a device which must control the steering response through speedy driving and even when tires defect exists for most control on vehicle.

KEYWORDS: Burnouts, Tafheet, Restrict Rotation, Non-Civilized Driving

INTRODUCTION

Statistical data are not available to analyze burnouts "Tafheet" and their adverse effect, but usually it's included in the statistics of traffic accidents and specifically under the name of the coup, driving at high speeds and collision. Statistical data show that over all the world annually 1,250,000 deaths, and 50 million obstruction (retardation) due to traffic accidents. Previous studies show that 85% of traffic accidents are caused by the human factor, which means that this issue does not need to emphasize as much as it need to analyze[9]. Rate of traffic accidents in the Kingdom of Saudi Arabia is one of the very high rates in the world; the statistics showed that 55000 accidents resulted in 2011 ranged from 39160 cases and 7153 deaths. Many of the reports showed that road accidents in the Kingdom of Saudi Arabia is the second leading cause of death for the age group of 5 to 29 years, and the third leading cause of death among the age group between 30 and 44 years old [6].Causes of traffic accidents are distributed among exceeded of speed limit (34%), and the rest falls under other different reasons (Table 1) [7].

Table 1: Causes of Traffic Accidents

Accident Cause	Number of Accidents	%
1- Exceed of speed limit	99.602	34
2-Non-compliance with traffic signal	13.861	4.73
3- Irregular Stop	26.432	9

Table 1: Contd.,

4- Irregular Turn	30.539	10.41
5- Irregular pass	27.001	9.21
6- Under influence of drug or drunk	325	0.11

With all respect to these statistics it doesn't address "Tafheet". Although it is one of the main causes of traffic accidents in Arab Gulf. "Tafheet" spreads in most Gulf countries, particularly in Saudi Arabia and practiced as a sports hobby among a class of reckless youth, where they drive vehicles in a non-civilized manner in order to manipulation and amusement.

"Tafheet" is driving a vehicle with very high speed, then suddenly changed the direction which could result in a catastrophic on all stakeholders of road (people in the vehicle or on the way of pedestrians, moved or parked vehicles and on the spectators.Due to this solutions proposed for "Tafheet" must be linked to vehicle steering system, this is the aim of this paper.

VEHICLE STEERING SYSTEM

A steering system is major automotive subsystems required for operation in the car [16]. It provides the driver control of the path of the car over the ground. Steering functions by rotating the plane of the front wheels in the desired direction of the turn (Figure 1).

The angle between the front wheel plane and the longitudinal axis of the car is known as "*steering angle"*. This angle is proportional to the rotation angle of the steering wheel (Figure 2).

There are two different types of steering systems. The most common are **rack-and-pinion** and **re-circulating ball.** Rack-and-pinion steering is quickly becoming the most common type of steering on cars, small trucks and SUVs. It is actually a pretty simple mechanism. A rack-and-pinion gear set is enclosed in a metal tube, with each end of the rack protruding from the tube. A rod, called a tie rod, connects to each end of the rack (Figure 3).

The steering ratio is the ratio of how far you turn the steering wheel to how far the wheels turn. For instance, if one complete revolution (360 degrees) of the steering wheel results in the wheels of the car turning 20 degrees, then the steering ratio is 360 divided by 20, or 18:1. A higher ratio means that you have to turn the steering wheel more to get the wheels to turn a given distance. However, less effort is required because of the higher gear ratio, Generally, lighter, sportier cars have lower steering ratios than larger cars and trucks.[12].

Some cars have variable-ratio steering, which uses a rack-and-pinion gear set that has a different tooth pitch in the center than it has on the outside. This makes the car respond quickly when starting a turn (the rack is near the center), and also reduces effort near the wheels turning limits (Figure 3).

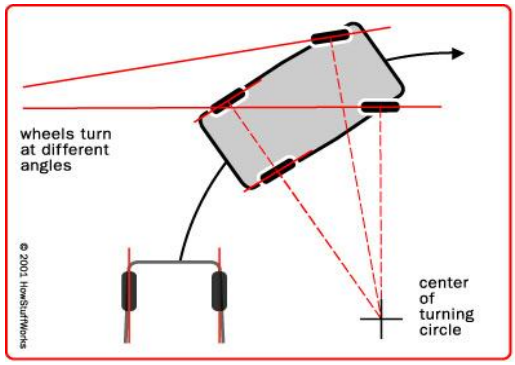

Figure 1: Vehicle Steering System

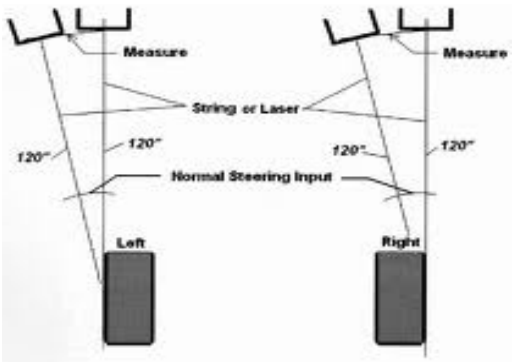

Figure 2: Steering Angle

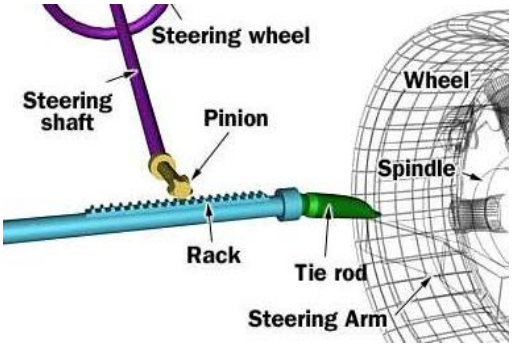

Figure 3: Rack-and-Pinion Steering System

Re-circulating-ball steering is used on many trucks and SUVs today. The linkage that turns the wheels is slightly different than on a rack-and-pinion system (Figure 4).

The re-circulating-ball steering gear contains a worm gear. You can image the gear in two parts. The first part is a block of metal with a threaded hole in it. This block has gear teeth cut into the outside of it, which engage a gear that moves the pitman arm. The steering wheel connects to a threaded rod, similar to a bolt that sticks into the hole in the block. When the steering wheel turns, it turns the bolt. Instead of twisting further into the block the way a regular bolt would, this bolt is held fixed so that when it spins, it moves the block, which moves the gear that turns the wheels [17].

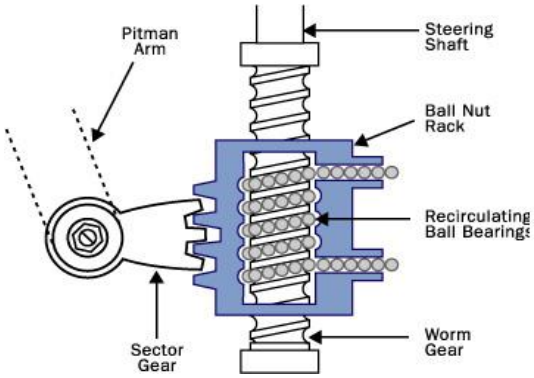

Figure 4: Re-Circulating-Ball Steering System

Power steering in a re-circulating-ball system works similarly to a rack-and-pinion system. Assist is provided by supplying higher-pressure fluid to one side of the block.

The characteristic of steering system is extraordinary critical to vehicle handling and stability, and the coulomb friction, which consist of steering gear coulomb friction and kingpin coulomb friction, are usually neglected in the many previous steering system model. The dynamic model of a hydraulic power steering system (HPS) includes 9-rotational and 1-translational degree-of-freedom (DOF) presented, by consider coulomb friction of steering and refer to dynamical theory a 2-DOF mathematical model established, based on that a simulation of vehicle handling stability evolved. The aims of effects of steering ration, stiffness coefficients and moment of inertia of parts on signs of handling and stability involving yaw rate [5]

The Control logic of electric power steering (EPS) using assist motor gives the driver smooth rotation depending on the driving conditions, Experimental studies show that the proposed EPS control logic can improve return-to-center performance of the steering wheel by control of the assist motor [15].

According to [13] motor driven power steering (MDPS) will be the main stream of future power steering systems and an intense target of technology innovation. Hae-ryong Choi focused on a computer simulations and experimental

results using a real car to evaluate on-center characteristics on MDPS. The steering system evolved in the vehicle to improve comfort, performance and safety [10].

For HPS system of model EIMCO 922 load-haul-dump vehicle the pre-charge pressure of nitrogen in steering accumulator should be 60%–80% of the rated minimum working pressure of hydraulic power steering system. The results of simulation characteristics of hydraulic power steering system are improved obviously by using bladder accumulator [14].

Roy McCann investigates a method for improving vehicle stability by incorporating feedback from a yaw rate sensor into an electric power steering system. The use yaw rate feedback improves vehicle stability by increasing the amount of tactile feedback when driving under adverse road conditions [18].

Zhen Zhang presents a new control method to improve the safety & performance of the electric-vehicle (EV) steering system. A new dynamic model proposed to describe the EV steering system, which takes into account the motor drive for EV propulsion [2].

Xiaojun Lv & Xi"an Jiaotong proposed a lateral mode by integrating of DGPS and INS via identifying approach for vehicle control system synthesis. Simulation results show that sliding mode controller with time delay can achieve satisfactory performance [11].

Introduce control strategy for the application of Active Front steering (AFS). A PID and feed forward controller is adopt in the front wheel system to control the tire, to found the optimal gain *K* for AFS algorithm. This will benefit on improving steer by wire system.[1].

A linear yaw-plane model is generated to derive an optimal active trailer-steering controller, the active trailer-steering controller can effectively improve the low-speed maneuverability and high-speed stability of the multi-trailer articulated heavy vehicle as mention in [4].

Probably the list has lengthened when you talk about the steering system of vehicles, aimed as a whole to develop the system and raise its efficiency, but with regret the phenomenon of “Tafheet” confined in some countries, so that the scientific research that aims to find solutions to prevent “Tafheet” doesn’t find any interest among folds.

DISCUSSIONS AND RESULTS

When steering the car, the driver must provide sufficient torque to overcome the restoring torque. Because the restoring torque is proportional to the vehicle weight for any given steering angle, considerable driver effort is required for large cars, particularly at low speeds and when parking. Boils down the working principle of the system; When the engine spins and vehicle begins to move, the control unit receives the speed signal, the proportioning valve opens, allowing air pressure to activate the actuator, the device starts to operate under the influence of air pressure on the entrance of the system and commensurate with the value of the vehicle speed at that moment (Figure 5, and 6).

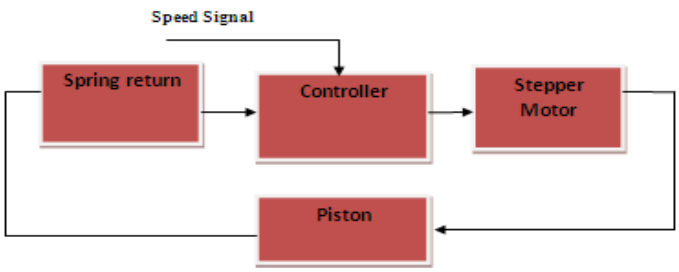

Figure 5: Control Loop

At the level of abstraction appropriate for the present discussion, an electronic system will be represented by a block diagram shown in Figure 6.

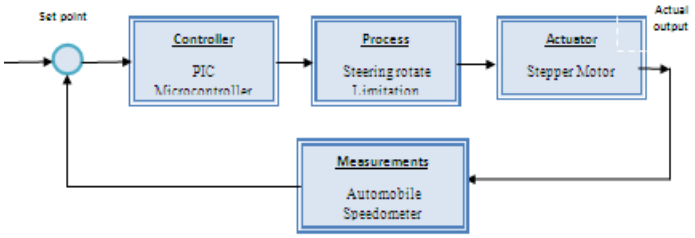

Figure 6: Control System Block Diagram

In designing a SSS device component (Table 2), we draw the basic shape of each component and the assembly of the machine with complete specification for the manufacturing processes accomplish after design calculation (Figure 7).

Table 2: Speed Suspension System Parts

Speed Suspension System (SSS)			
Part Number	**Part Name**	**Material**	**Notes**
1	Steering	-	-
2	Pinion	HSS	helical
3	Gear	HSS	helical
4	Bearing	standard	selection
5	progressive cylinder (Drag limiter)	Steel	AISI 10xx
6	Spring	standard	selection
7	Hexagonal shaft	steel	AISI 10xx
8	Speed key	HSS	AISI xxx
9	mechanism	Steel	Helical gears
10	Actuator	-	Stepper motor

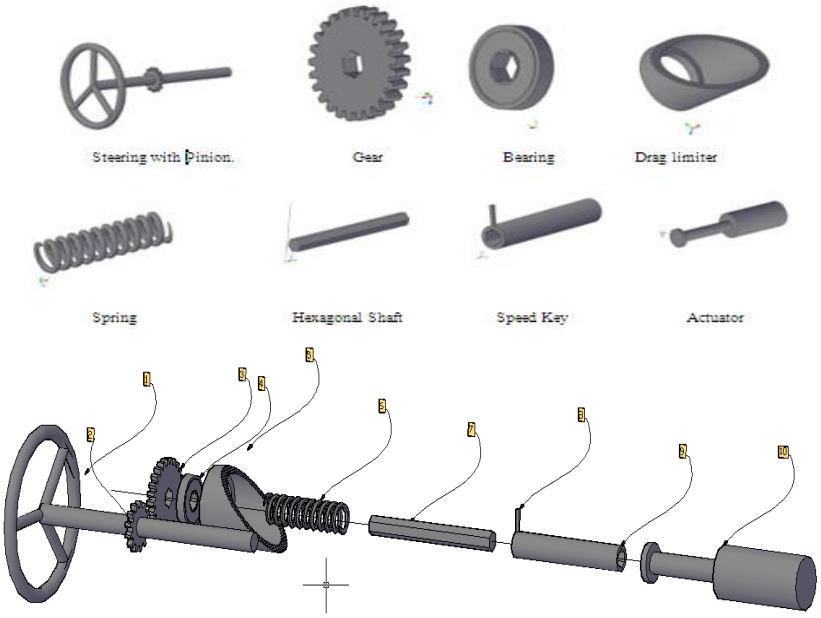

Figure 7: SSS Basic Parts and Components

The working principles of the device can summarized as following:

As mention before when the engine is turned and vehicle starts move, the control unit receive the speed signal, the proportioning valve opens, allowing air pressure to activate the actuator. The high-pressure of air pushes on the piston of

the actuator 10 push the connecting rod 9 with key 8 and compressing the spring 6, by commensurate with vehicle speed. With the arrival of key to the divided cylinder (Staging) 5 (Figure 7), which installed on the steering column, collides with its edges depending on the speed rushes inside, which depends on the speed of the vehicle.

The movement key linear and rotational at the same moment, so with increasing vehicle speed, the rotation angle of the key become less, because of the narrow field of rotation, which at least with a dash inside the cylinder, and therefore less possibility of rotation of the vehicle steering column with increased speed. The key is connected to the hexagonal shaft 7 and limit the mechanical torque to prevent the driver in sudden turning.

SSS DESIGN ALGORITHM

Algorithm in this design work will begin to choose the appropriate spring to achieve the required shifts which need to identify the required torque to move the group**,** it is best to be chosen from one of the spring manufacturer to the required size of SSS, the stepper motor must be chosen to bring compression on the spring (table 3).

As shown in the table PIC microcontroller will be programmed to give 10 orders at in 10 positions. Maximum position has been selected at 120 km/hr according to traffic law in the Kingdom of Saudi Arabia.

Table 3: The Algorithm Design

Step	Status*	Speed Limit	Position	Steering Angel	Time
1	Stand By	0-20	Nul Position	Full rotation	-
2	$P_1 = 5$	40	$X_1 = 40$ mm	θ_1	Time is determined by the controller Differentially
3	$P_2 = 6$	50	$X_2 = 48$ mm	θ_2	
4	$P_3 = 7$	60	$X_3 = 56$ mm	θ_3	
5	$P_4 = 8$	70	$X_4 = 80$ mm	θ_4	
6	$P_5 = 9$	80	$X_5 = 88$ mm	θ_5	
7	$P_6 = 9$	90	$X_6 = 96$ mm	θ_6	
8	$P_7 = 13$	100	$X_7 = 104$ mm	θ_7	
9	$P_8 = 14$	110	$X_8 = 112$ mm	θ_8	
10	Maximum compression $P_9 = 15$	120	Maximum position = 120mm	Full rotation	

* As shown on scale below on the cylinder surface (Figure 8).

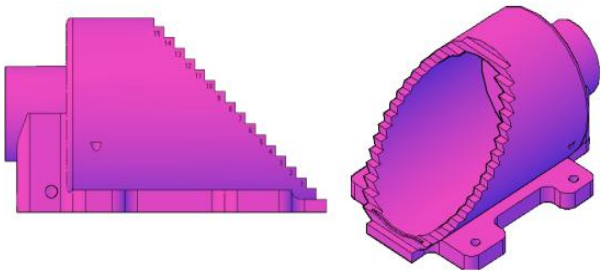

Figure 8: Staging the Outer Surface of the Cylinder

Staging shown on the outer surface of the cylinder represents the position according to speed. Not necessarily be attributed to the progress of the index equal by staging shown for, the divisions are as set out in the table above.

Note that each age is on the surface of the cylinder length of 8mm and the total number of scales on the surface of the cylinder equal to 15.So the maximum displacement of the spring must equal to 120 mm.

Assembly drawing of SSS device is shown in Figure 9.

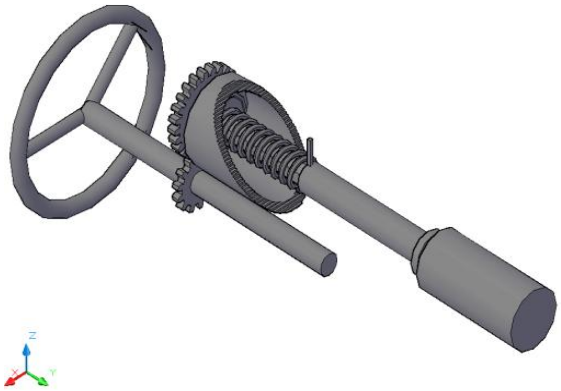

Figure 9: Pictorial Projection for Assembly Drawing of SSS

SSS device can install in many places and for any type of vehicle (Figure 10)

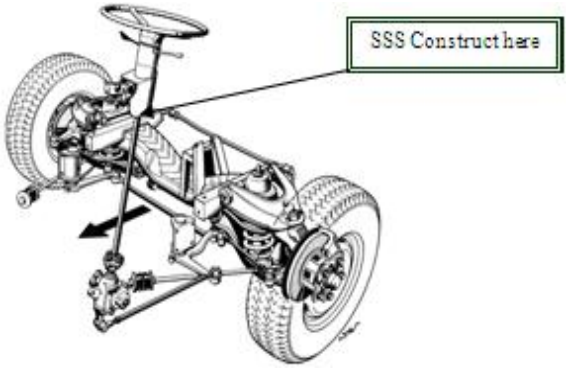

Figure 10: Front Axle on the VW Light Commercial Vehicle

CONCLUSIONS

- "Altafheet" is one of deadly games which is spread among young people in most countries of the Arabian Gulf in general, particularly Saudi Arabia.
- Despite of all preventive measures, awareness and guidance used by the authorities of Saudi Arabia, problem of "Altafheet" doesn't solve till now.
- "Altafheet" doesn't receive researcher's interest since it's considering geographical problem.
- In addition to the basic function of the device in solving the problem "Altafheet" by restricting the movement of the vehicle steering column rotation, so that it becomes inversely proportional to the speed another advantage is to help stabilize the vehicle in the event of a defect in one tire.
- The proposed device is simple in terms of its components and can be mounted on any kind of vehicle and anywhere.

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