National conference on Technology innovation in Mechatronics,Energy Management and Intelligent communication(NCTIMEMIC-2017)

International Journal of Advanced Scientific Technologies ,Engineering and Management Sciences (IJASTEMS-ISSN: 2454-356X) Volume.3,Special Issue.1,April.2017

Compensation of Friction in Electric Power Steering

Athira Vijayan
Department of Applied electronics and Instrumentation
Mohandas college of engineering and technology
Trivandrum, india
athiravijayanstar007@gmail.com

Renjitha G Nair
Department of Applied electronics and Instrumentation
Mohandas college of engineering and technology
Trivandrum, india
renjitha@gmail.com

Abstract—Vehicles having Electric power steering system needs to provide good driving feel. Static friction makes discomfortability while travelling through straight road. The steering system becomes static at that time. The presented close loop system shows that actual path of simulation graph follows ideal path in the simulation result. The bad consequences of static frictional effects can be easily avoided by using this technique. Optimization of gain parameters by using Artificial Bee Colony algorithm is demonstrated in this paper. Artificial Bee colony algorithm shows better result in optimization problem.

Index Terms—Electric power steering system, Friction Compensation, Gain variation, Simulation Results

I. INTRODUCTION

The need of vehicle is increasing day by day. Four wheelers having good stability and good maneuverability provides high demand for car systems. But the frictional effects of the each component make discomfortability while driving. We all know friction is a necessary evil. Some time it is needed and other times it is not necessary. In the car systems, Frictional effects make difficulties in tuning of the steering systems.

Frictional effects vary for different weather conditions such as snow, rain etc. The friction can be written as

$$F=\mu N \quad (1)$$

Where F - the frictional force
μ - Coefficient of friction
N- Normal reaction

Here friction coefficient is varying for each region. It can be either negative or positive. Snow region become hard to travel because of slippery. The tires of the vehicle try to grip onto the vehicle at that time. But road will not provide sufficient friction.

In the heavy rainy regions, they use special type of tires. The same car cannot travel through both regions. In the figure we can see special type of tire used. In the figure, the tire is designed to allow the water to go from under the wheels. It allows the tire to stay in contact with the road and providing the traction needed to stay on the road. In fig.1 the frictional force is proportional to the applied force at the steering system. We can see a linear relationship between them.

The organization of paper is as follows structure of power steering system in section II, Block diagram in section III, algorithm in section IV, result in section V, Finally conclusion in section VI.

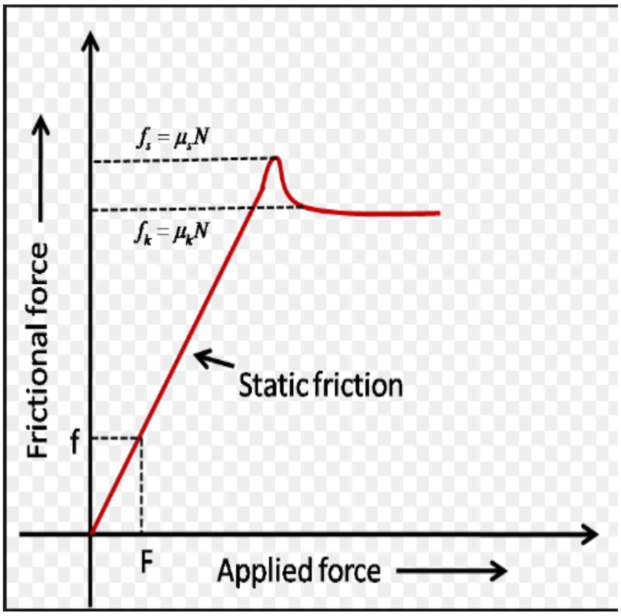


Figure.1.Tire designed for rainy conditions

Figure.2.Tire designed for rainy conditions

II. STRUCTURE OF POWER STEERING

Figure.3. Power steering system

Hard effort is taken to drive through the road by the drivers in previous years. But now it becomes very easy to drive through anywhere. It consists of steering wheel, Electronic control unit, assist motor etc. Frictional effects make inaccurate tuning while driving. Electronic control unit produces required information to compensate friction.

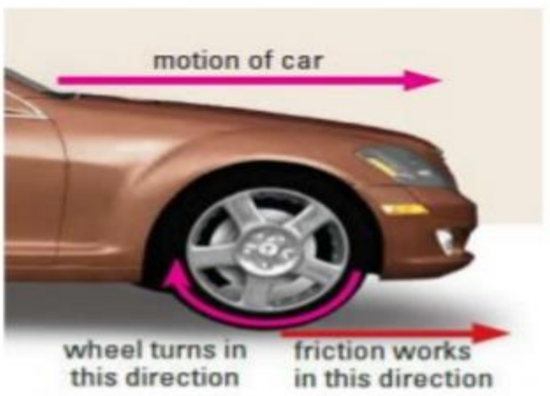


Figure.4. Friction acts on motion of a car

In the figure, we can see friction always acts on opposite side of the movement. These frictional effects make resistance to the motion. So travelling becomes very difficult.

III. PROPOSED METHOD

Reference model is designed as ideal frictionless plant. EPS take actual measurements. Controller controls the error between them.

$$T_{mc} = T_a + (i - 1)\mu N(dh) + k_p e_1 + k_v e_2 \quad (1)$$

Where
Tmc –Motor torque command
Ta -Applied torque
µ -Coefficient of friction
Kp- Position gain
Kv- Velocity gain
i -Gear ratio
e_1 - Error in angular positions
e_2-Error in angular velocities

Compensated torque is added to the applied torque to cancel the frictional effects.

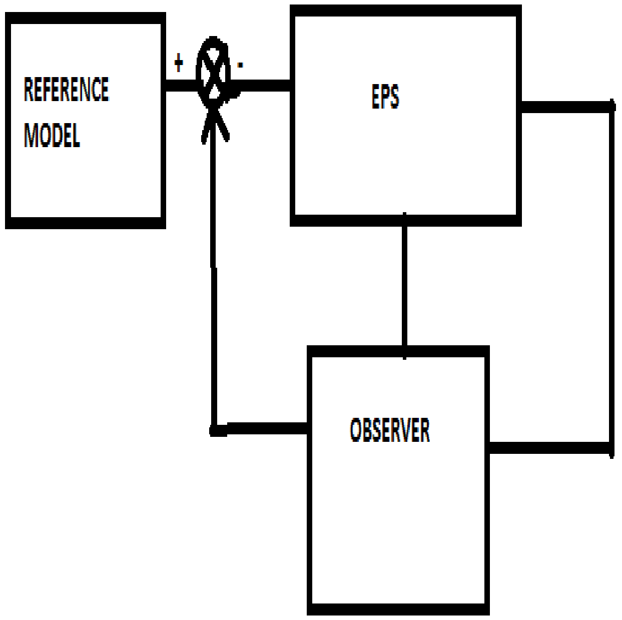


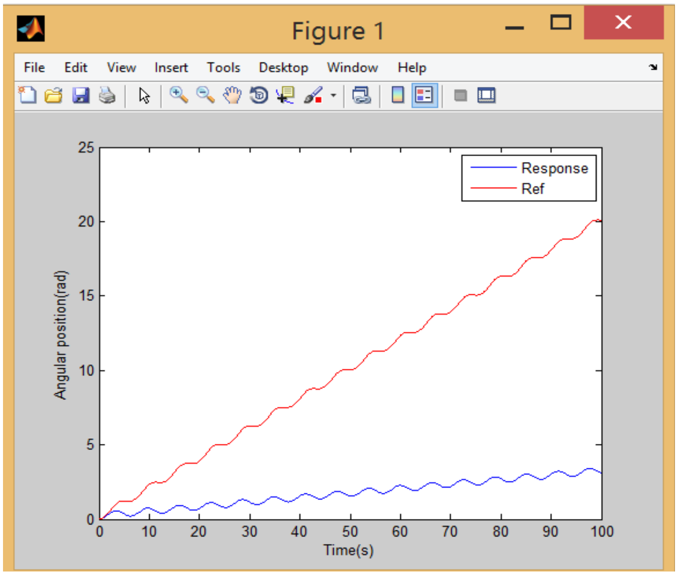
Figure.5. Close loop response

IV. PROPOSED ALGORITHM

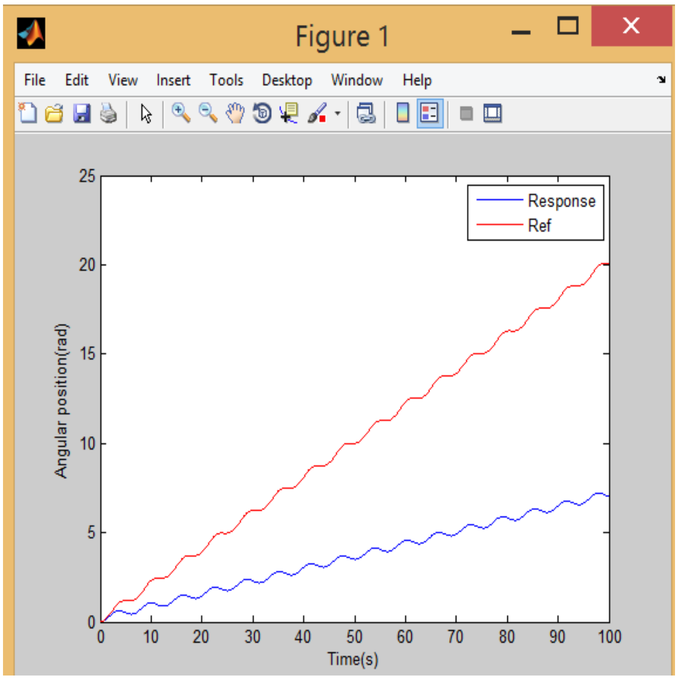
The Artificial Bee colony algorithm is to optimize the parameters. It can do this through three main phases called Employed bee phase, Scout Bee phase and Onlooker Bee phase. Simulation results are shown in next section.

V. RESULT

The simulation shows various results in MATLAB software. The following figures show the variation gain parameters. The error can be minimized by increasing the position gain Kp and velocity gain Kv. Each variation are shown in following figures.



(a)

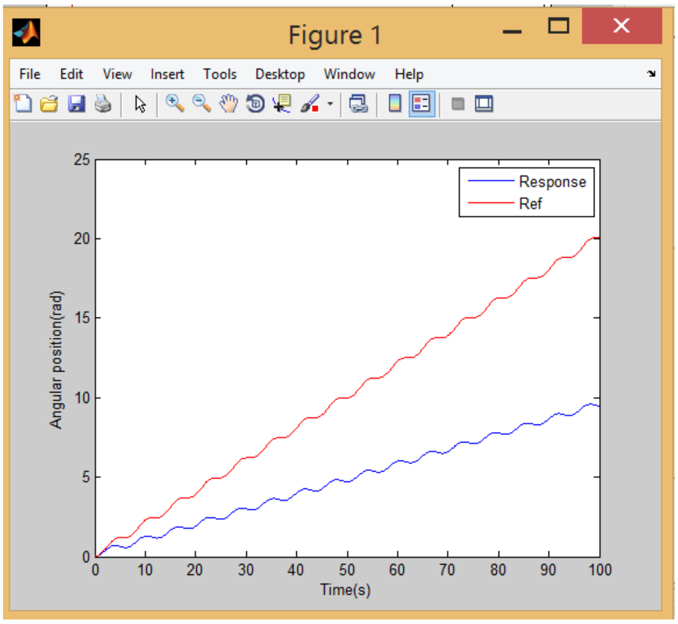


(b)

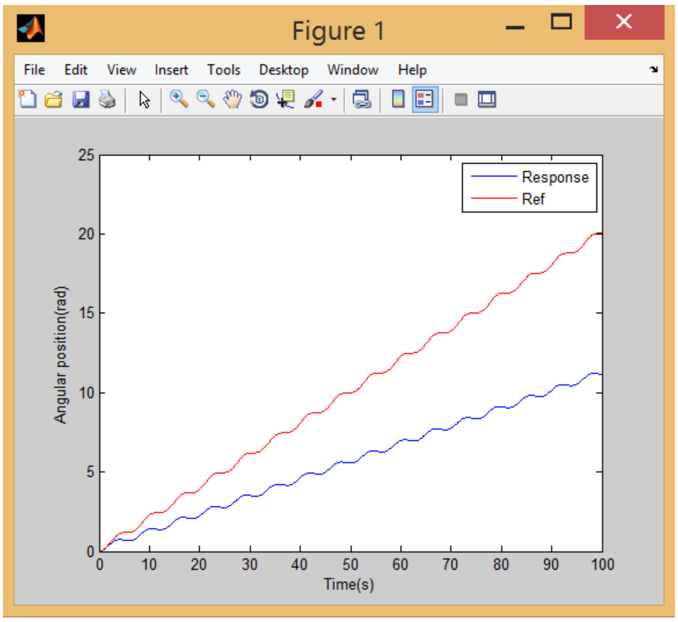
In the first f ig.(a) Kp and Kv values are 1. In fig(b) changed it to 3. There is a large variation between actual trajectory and ideal trajectory. In the next fig (c) Kp and Kv values are equal to 5. The error between those two paths reduced. Again increases the gain values to 7 in fig (d).

In (e) Kp and Kv values become 9.The difference between actual trajectory and reference trajectory become very less. Again we increased to Kp = 11 and Kv =11 in (f).

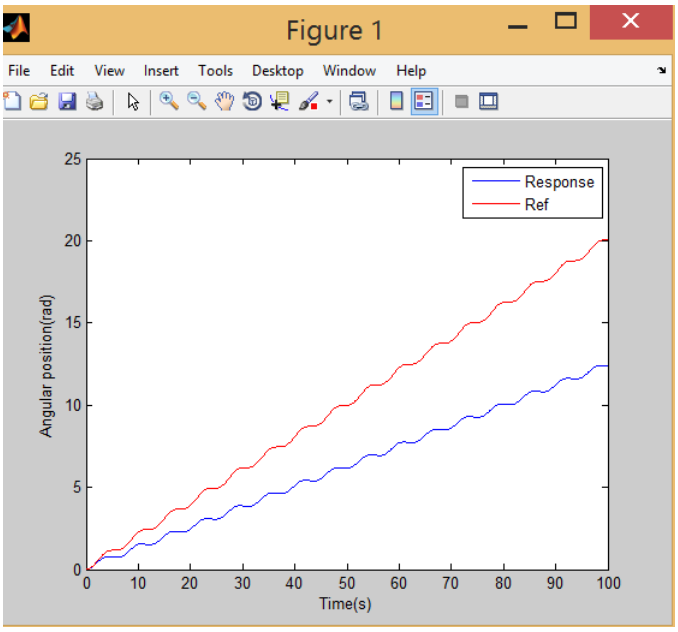
Kp and Kv values are 15 for the figure (g). Again increases to 20. Actual trajectory becomes closer to the ideal trajectory. Gain for (h) is 25. For the large gain, difference between actual trajectory and reference trajectory can be reduced.



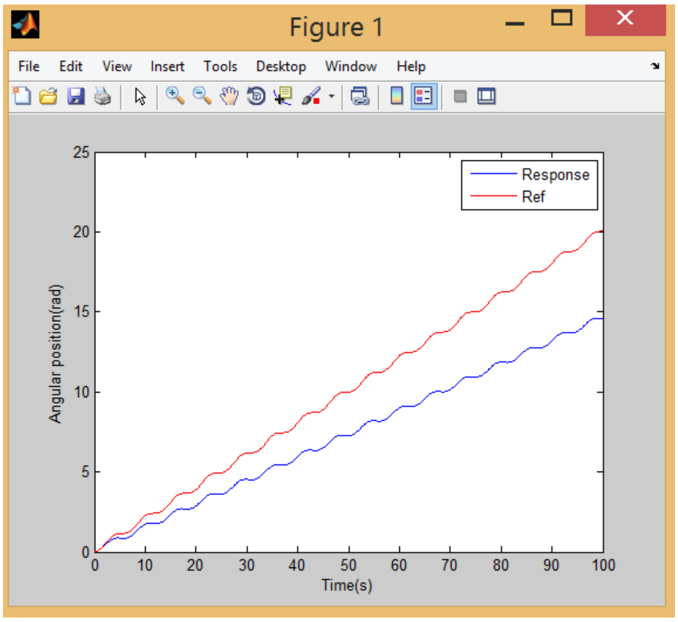
(c)



(d)



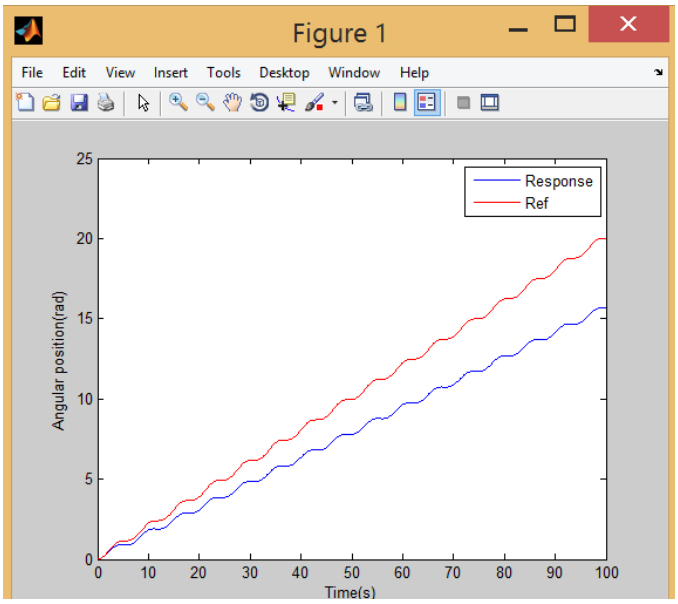
(e)



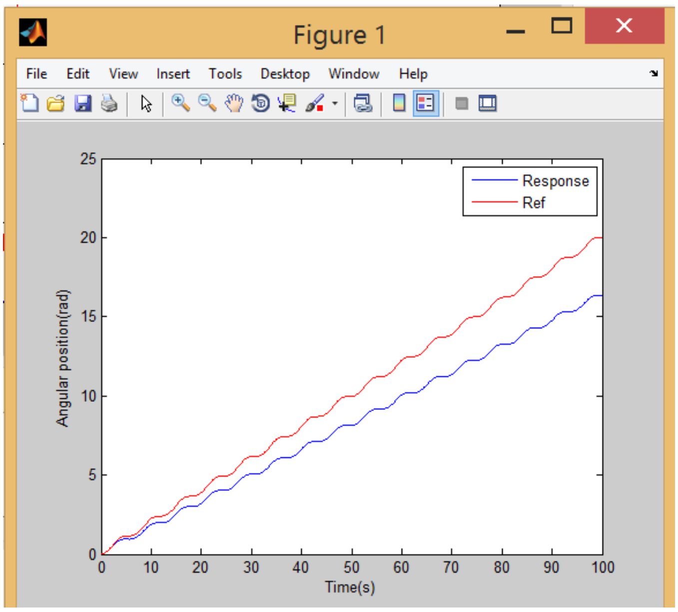
(f)

It is difficult to choose gain values randomly . So Artificial Bee Colony algorithm can be used to optimize the values.

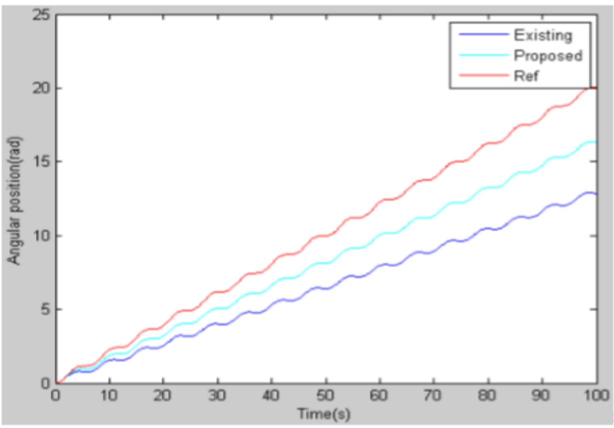
In the figure (i) ,we can easily optimize the gain values by using Artificial Bee Colony algorithm. It shows better performance. The blue line indicate simulation trajectory. Red graphs shows reference trajectory. Green graph shows optimized result. The difference between optimized graph and reference is very lesser than the difference between reference and simulated unoptimized graph.



(g)



(h)



(i)

VI CONCLUSION

The Electric power steering system provides good tuning on steering in static condition by avoiding bad effects of friction. Simulation results show the better optimized performance in power steering systems.

REFERENCES

[1] C. Morton, C. M. Spargo, and V. Pickert, "Electrified hydraulic power steering system in hybrid electric heavy trucks," *IET Elect. Syst. Transp.*,vol. 4, no. 3, pp. 70–77, Sep. 2014.

[2] H. Miyazaki, "Technical trends in steering systems," in *Proc.7th JFPS Int. Symp. Fluid Power, Toyama, Japan, Sep. 2008*, pp. 133–136.

[3] A. Badawy, J. Zuraski, F. Bolourchi, and A. Chandy, "Modeling and analysis of an electric power steering system," in *Proc. Steering Suspension Technol. Symp., 1999, paper 1999-01-0399.*

[4] J. T. Illán, V. Ciarla, and C. C. de Wit, "Oscillation annealing and driver/tire load torque estimation in electric power steering systems," in *Proc. IEEE Int. Conf. Control Appl., Denver, CO, USA, Sep. 2011*, pp. 1100–1105.

[6] R. C. Chabaan and L. Y. Wang, "Control of electrical power assist systems: *H∞ design, torque estimation and structural stability," JSAE Rev., vol. 22, no. 4, pp. 435–444, Oct. 2001.*

[7] N. Sugitani, Y. Fujuwara, K. Uchida, and M. Fujita, "Electric power steering with H-infinity control designed to obtain road information," in *Proc. Amer. Control Conf., vol. 5. Jun. 1997, pp. 2935–2939.*

[8] T. Kifuku and S. Wada, "An electric power-steering system," *Mitsubishi Electr. Adv., vol. 78, pp. 20–23, Mar. 1997.*

[9] T. Tamura, A. Maroonian, M. Higashi, and R. Fuchs, "Modeling and simulation for the dynamic analysis of an electric power steering," in *Proc. 3rd Int. Munich Chassis Symp., Munich, Germany*, Jun. 2012.

[10] T. Tamura, A. Maroonian, and R. Fuchs, "Active compensation of friction in electric power steering," in *Proc. FISITA, Beijing, China*, Nov. 2012, pp. 213–225.

[11] A. Marouf, M. Djemai, C. Sentouh, and P. Pudlo, "A new control strategy of an electric-power-assisted steering system," *IEEE Trans. Veh. Technol., vol. 61, no. 8, pp. 3574–3589, Oct. 2012.*