Indian National Society for Aerospace and Related Mechanisms

BANGALORE CHAPTER

E-NEWSLETTER

Vol.7, No.1, July 2015

From the Editor

Dear Member,

It gives me great pleasure to present you with this edition of E-newsletter. The first half of this year was significant for the members of Spacecraft Mechanisms Group (SMG) at ISAC, as the team witnessed on-orbit deployment of solar array onboard IRNSS-1D spacecraft. With this, SMG has completed 175 successive successful on-orbit deployments. The editorial committee congratulates the past and present members of Spacecraft Mechanisms Group, ISAC for this excellent achievement.

I am happy to inform that *Aerospace Related Mechanisms Symposium - ARMS 2015* was held on 30th and 31th January 2015 at ISAC. The seminar was well attended and 103 papers were presented during the two day seminar. Two papers written by the INSARM, Bangalore chapter, members bagged the first and third best paper award. The editorial committee congratulates the authors for their excellent achievement. This issue of news letter gives the extended abstracts of the award winning paper titled “Dynamic Synthesis of Single d.o.f. Mechanisms” and “Influence of Contact Geometry on the Stability of a Three Position Toggle Switch” for the information of the members.

Our INSARM Bangalore chapter member *Sri.Shamrao*, SMG, ISRO Satellite Centre is the recipient of *ISRO young scientist merit award 2010 for* his significant contribution in the field of lunar rover wheel soil interaction studies. The editorial committee congratulates for his outstanding achievement. I request all members to update us with latest awards to enable us to publish the same in E news letter.

This news letter is intended to be a platform for the exchange of information regarding the current developments, new ideas and novel concepts in the area of mechanisms and related field through active participation of members. I request all INSARM members to actively contribute technical articles related to mechanisms to enhance the technical value of the e-new letter.

With best regards,
Dr. B.P. Nagaraj
Chief Editor

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Quote:

"Innovation comes only from readily and seamlessly sharing information rather than hoarding it."

By Tom Peters

INSARM BANGALORE CHAPTER

Newsletter

GLIMPSES OF ARMS 2015

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Release of Souvenir

Inauguration of Exhibition

Best Paper Award Winner

Valedictory Function

INFLUENCE OF CONTACT GEOMETRY ON THE STABILITY OF A THREE POSITION TOGGLE SWITCH

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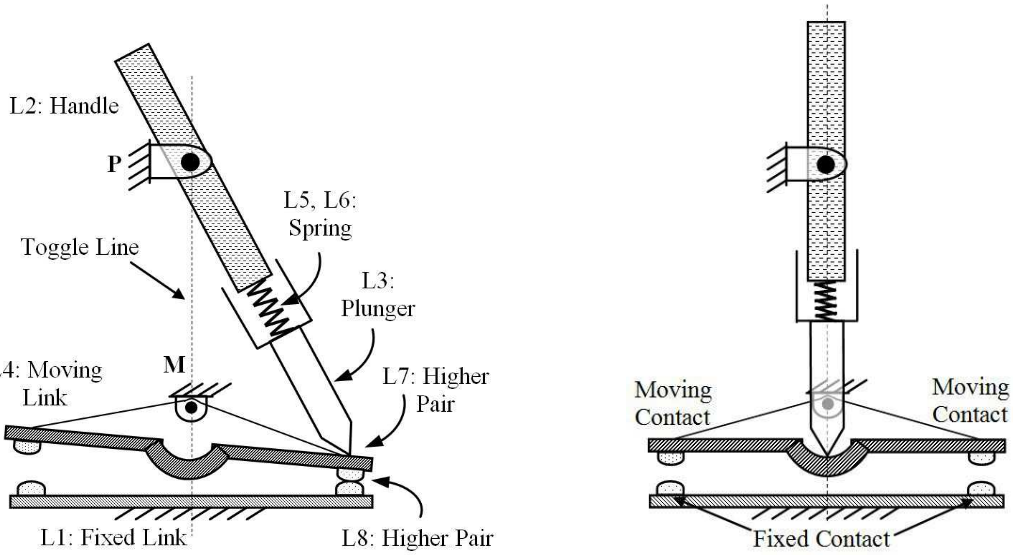
Extended Abstract

In the most common forms of electrical switches there is a link, called *handle*, the user's input on which moves a current carrying member to make a specific region on it, called *moving contact*, to come in contact with another specific region on a fixed link called *fixed contact*. The design of a switch involves achievement of the desirable motion characteristic for the link carrying the moving contact (this link is called as *moving link*) to achieve a desirable electrical performance [1]. Most commonly used electrical switches have two stable positions as OFF and ON state. But, a switch may have multiple stable positions depending upon the application requirement. For example, a three position switch [2] has three stable positions as ON-OFF-ON. Malfunctioning of the operating mechanism of the three position switch is a common problem. Often it loose its stability at the centrally located OFF position and starts acting as a two position switch. One possible reason behind this could be change of the inside geometry due to temperature or repetitive operation. This problem becomes more challenging for the switches, used in residential application where size of the switch is a constraint. In this situation, the operating mechanism of the switch is required to be small and compact. This paper focuses on the influence of contacts geometry on the stability of the toggle type three position switches.

A three position switch as shown in Fig. (1), normally controls power supply in two different electrical circuits. There are two sets of electrical contacts where each set is responsible for controlling the power in the respective circuits. The handle L2 is pivoted to the fixed link L1 and a plunger L3 is connected with the handle with help of a prismatic joint. The plunger maintains a higher pair contact with the moving link L4 which helps to operate the moving link through user input on handle. When the handle is in OFF position as shown in the Fig. (1b), the power supply is cut from both the circuits. The theory developed enlists the necessary conditions to design such system and the influence of the geometry of higher pair contacts in the system performance.



(a) Right Circuit ON Position (b) OFF position

Figure 1: Operating Mechanism of a Three Position Toggle Switch

Although the mechanical construction of the switches [3] seems to be simple, their behavior is rather complex. The electrical characteristics of a system define operating time of a switch. The mechanical construction including the number of stable positions, operating mechanism type, force input methods are defined by the application. This paper establishes that the switching behavior of a mechanism can change significantly with the profiles of the higher pair contacts. This also affects the stability of the system. Detail study on the operating mechanism of three position switch reveals that it is not enough to know the presence of the higher pair contact in the system, but their geometry plays a major role in the mobility. Effect of the surface profile of circular and non-circular contact on the switching mechanism has been studied. It is established that construction of a three position switch becomes impossible with the plunger making a point contact with the moving link. The mechanism with non-circular profile match between the plunger and the moving link is considered as the most suitable mechanism to construct a three position switch.

References

[1] Manan Deb, Dibakar Sen, *"Parametric Study of the Behavior of Double Toggle Switching Mechanisms"*, Mechanism and Machine Theory, Volume 63, May 2013, Pages 8-27

[2] *"Switch Training Manual"* by Commercial Controls Division, Eaton

[3] Miloš Milošević, Slobodan Jovanović, *"Structural Analysis of Mechanical On-Off Switches Driving Mechanisms"*, The Scientific Journal FACTA UNIVERSITATIS, Series: Mechanical Engineering Vol. 1, No 5, 1998, Pages 621-628

DYNAMIC SYNTHESIS OF SINGLE D.O.F. MECHANISMS

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The dynamic synthesis of the mechanism gives inertial properties of the links for a required dynamic performance. One of the dynamic performance parameters is time. The inertial properties are mass, moment of inertia and centre of gravity (c.g.) location. For dynamic synthesis there must be criteria for which the inertial properties must be optimized. For example, consider a situation in mechanism in which a link has to move from one position to another in a particular time. The time taken to travel depends on the configuration, dimensions and the inertial properties of the links. To optimize the time, for a given configuration and dimensions, inertial properties can be obtained. This is a part of dynamic synthesis. Any constrained method of optimization can be used to do dynamic synthesis for inertial properties. These three inertial properties are independent of each other, so many solutions exist, if one of them is kept constant. Hence, in the constrained method of optimization initial solution is to be given in the form of area, c.g. location and moment of inertia. Here even in c.g. location there are two independent parameters (x_{cg}; y_{cg}) coordinates. Hence, for each link there are four variables, making it 4 X (n - 1) design variables for a mechanism having n links ((n - 1) is obtained by neglecting the ground link). Our objective function is formulated in the form as

$$Objective\ Function\ = \left(\frac{t-t_{desired}}{t}\right)^2 \times 100 \quad \text{......(1)}$$

Where t=time calculated for a set of design variables and $t_{desired}$=desired time. The design variables with their constraints are the following:

1. Centre of gravity location (x_{cg}; y_{cg})
2. Mass (M >0)
3. Moment of inertia ($I_{cg} > 0$) about an axis through centre of gravity

The main task is to calculate time taken by a link in a mechanism from one configuration to another if *n* link dimensions, inertial parameters and forces acting on them are given. For this, Quinn's energy distribution method mentioned in [1] is used. Quinn's energy distribution method is used because it does not involve any complex differential equations and easily solved using only law of conservation of energy principle. This method requires kinematic analysis at each phase of the mechanism which is done by the in-house modular kinematics library i.e. already available in [2]. Then the time (t) to be calculated is formulated as a function of 4 x (n - 1) inertial parameters as design variables in the form shown as

$t = f(m_i; mi_{cgi}, cg_{xi}, cg_{yi}) \; \forall \; i = 0, 1, 2, \dots ; n - 1$ …………………………………………(2)

This function is used in the objective function mentioned in equation (1). After the time is calculated, the next task is to minimize the objective function (equation 1), if possible, with some constraints on inertial parameters. This minimizing the objective function is done by using Nedler and Mead's downhill simplex method mentioned in [3]. It uses the concept of expansion, contraction and reflection or a combination of these. The objective function can be changed accordingly to accommodate upper and lower limits for the inertial parameters.

References

[1] J. Hirchhorn (1962), Kinematics and Dynamics of Plane Mechanisms, Mc-Graw Hill Book Company.

[2] Sekhar Chowdary, V. S. C. (2006), Modular Kinematic Analysis of Planar Linkages, M.Sc.(Engg.) Thesis, Indian Institute of Science, India.

[3] Nelder, J. A. and Mead, R, (1965) A simplex method for function minimization, Computer Journal,7(4), pp. 308-313.

CONGRATULATIONS TO THE AWARD WINNER

Sri Shamrao,
Scientist/Engineer 'SE',
Spacecraft Mechanisms Group
ISAC/ISRO Bangalore

ISRO Young Scientist Merit Award 2010

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FORTH COMING SEMINARS

1) Indian National Conference in Mechanisms and Machines, iNaCoMM 2015
   December 16th to 19th, 2015, Organized by IIT Kharagpur
   Wesite: ***www.iitk.ac.in/inacomm15/index.html***
2) International Conference on Man and Machine Interfacing, MAMI 2015
   December 17th to 19th, Organized by CVRCE, Bhubaneswar, India
   Wesite: ***cvrce.edu.in/mami_home.html***

INVITATION FOR ACTIVE PARTICIPATION

We invite you to send technology news, technical articles, members' news and suggestions/comments on e-newsletter and the web contents to Chief Editor to improve the newsletter. The technical articles may be limited to 400 words only in MS Word format with two photographs. The direct extracts from references may be avoided. Kindly provide your e-mail & mail address to enable us to contact you.

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