Indian National Society for Aerospace and Related Mechanisms
BANGALORE CHAPTER

E-NEWSLETTER

Vol. 2, NO. 1, February 2008

From the Editor

Dear Member,

At the outset, wish you and your family a very happy and prosperous New Year 2008. The members of the editorial committee feel privileged to be associated with this e-newsletter.

In November 2007, INSARM Bangalore chapter organized a seminar on Aerospace Mechanisms with the theme "Role of Robotics in Aerospace Applications" at ISRO Satellite Centre, Bangalore. Sri. V. R. Katti, Programme Director, GEOSAT inaugurated the website of INSARM Bangalore Chapter. Dr. V.K. Aatre, former scientific advisor to Defence Minister gave the keynote address. This was followed by invited lectures by Prof. K Kurien Issac (IIT, Mumbai), Dr. R Sunder (Biss Ltd, Bangalore), Dr. V. Krishnan (Associated Director, IISU) and Prof. G.K Ananthsuresh (IISc) on topics of great relevance to robotics. The seminar was well attended and appreciated.

This newsletter is intended to be a platform for the exchange of information regarding the current developments, ideas and concepts in the area of mechanisms and related fields. This is possible only by your active participation. I request you to contribute actively to enhance the technical value of this e-newsletter.

With best regards,

Dr. R Ranganath
Chief Editor

CONTENTS

WISH YOU HAPPY AND PROSPEROUS NEW YEAR 2008

FROM INSARM BANGALORE CHAPTER

Forthcoming conference/seminars

6TH NATIONAL SEMINAR & EXHIBITION ON AEROSPACE AND RELATED MECHANISMS, AT ARDE, PUNE, ON 28-29 MARCH 2008.
www.insarm.org

5TH ISSS INTERNATIONAL CONFERENCE ON SMART MATERIALS, STRUCTURES AND SYSTEMS AT IIS, BANGALORE, ON 24-26 JULY 2008.
www.isss.in

Novel Method of Retaining Turnbuckle Assembly Orientation

N Viswanatha, SMG, ISRO Satellite centre
A Shankara, SMG, ISRO Satellite centre

Turnbuckle assemblies are used to adjust and set the linkage length for achieving the required position of a link in mechanism assemblies or to increase/decrease the loading on a member by altering the length. After setting the required length/load of the turnbuckle, the end screw terminals are locked in position by two lock nuts. Generally, turnbuckle assemblies are made of LH and RH thread end terminals; so as to adjust the length without turning the end terminals. The other type of turnbuckle assembly is differential pitch screw type. This is used when very fine (micro) length adjustment is required. In both the types, since both ends of turn buckle are threaded, turnbuckle assemblies do not have provision to maintain the end terminals relative rotational orientation. The relative orientation during adjustment has to be maintained by external fixture.

A simple novel method of maintaining the end terminals relative rotational alignment which is included in differential pitch screw type turnbuckle assembly of satellite antenna deployment mechanism is explained below.

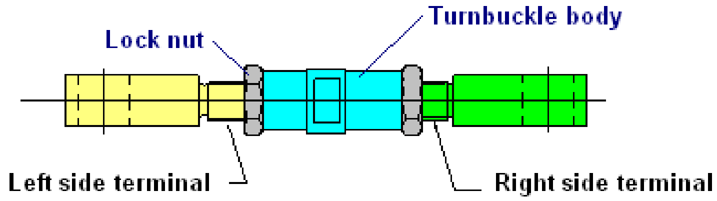


Figure-1 Differential Pitch Screw Type Turnbuckle Assembly

A typical differential pitch screw type turnbuckle assembly is shown in Figure-1. The mechanism of length adjustment consists of differential pitch screw principle. One side of turnbuckle body consists of RH screw (Right side terminal) of coarse pitch ‘X’ and other side consists of RH screw (Left side terminal) of fine pitch ‘Y’. These screw terminals are connected together using a turnbuckle body, which is having RH thread of coarse pitch ‘X’ on one side and RH thread of fine pitch ‘Y’ on the other side. Lock nuts having matching pitch are provided to lock the thread joints on assembly after achieving the required length and orientation of left side member of turnbuckle with respect to right side member. This type of turnbuckle assemblies are being used in space applications. Many applications require maintaining accurate rotational orientation between left side terminal and right side terminal during-and-after assembly and length adjustment. This rotational orientation accuracy depends on the skill of the operator and accessibility in addition, accurate inspection is required to ensure the orientation.

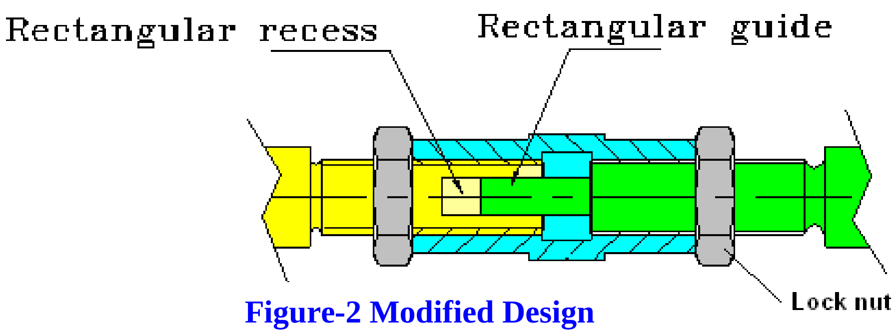


Figure-2 Modified Design

In order to overcome the above limitations and avoid assembly slip-up, a new design to ensure rotational orientation without many changes to the existing hardware was thought of. A simple modification: a rectangular pin type extension at the end of the right side screw terminal and a mating rectangular recess in the left side screw terminal were included as shown in Figure-2, to keep the two ends linked. The rectangular recess and pin projection are machined in the required angular orientation. The dimensional and geometrical tolerances on the recess and guide were given such that smooth sliding is possible with very small play along the turnbuckle axis. With the new novel guiding arrangement, the adjustment of turnbuckle length is made easy and orientation requirement of left side terminal of turnbuckle with respect to right side terminal is ensured and is foolproof. As the modification did not alter strength margins much and changes were internal to the assembly, it did not call for any changes on other parts.

LITERATURE RELATED TO MECHANISM

1. General specifications for assemblies, moving mechanical for space and Launch vehicles. –
   MIL-A-83577B dated Feb 1998.
2. Spacecraft deployed appendages design guidelines-
   NASA engineering networks Public lesson learned entry-0687.
3. MIL standard for Moving Mechanical assemblies-
   AIAA-S-114-2005.
4. Survey of Micro Actuator Technologies for future Spacecraft Applications-
   http://www.robotstore.com/support.asp
5. MIL Handbook for Metallic material and elements for aerospace vehicle structures-
   MIL-HDBK-5H dated 1st DEC. 1998.
6. MIL standard for structures, structural components and structural assemblies
   AIAA-S-110-2005.
7. Microswitches, sensitive, SPDT, Leaf actuator–
   MIL-PF-8805/84 dated: 10th April 2006.

(Courtesy: TP Murali, SMG, ISAC)

Unfurlable Antenna Mechanism – Challenges and trends

N S Murali, SMG, ISRO Satellite centre

Antennas are key elements in communication satellites. The gain of an antenna is a function of power and aperture diameter. As the antenna diameter increases, it needs to be folded during launch due the limitations in diameter of launcher. Antennas varying from 3 m diameter to 20 m have been deployed on-orbit. Basically there are two different types of unfurling antennas – mesh antenna and solid surface antenna. In both types of antennae, challenge is to accurately shape the surface and developing a suitable mechanism for unfurling the antenna from stowed to deployed configuration, keeping weight as minimum as possible. Typically a reflector real mass density of less than 0.5 kg/m2 is considered as an efficient design. Another challenge is to achieve a high stowed to deployed volume ratio. Antennae with ratios of more than 15 have been successfully demonstrated. To control the spacecraft, deployed antenna natural frequency of the antenna of 1 to 2 Hz is to be achieved. This calls for reducing weight and use of stiffer materials and mechanism joints. Antennae with different mechanisms have been developed as described below.

Radial Rib Antenna: Harris corporation, USA developed the 5m radial rib antenna for Tracking and Data Relay Satellite (TDRS) and for NASA's Galileo spacecraft (Ref. Fig. 1). 18 parabolic tubular graphite epoxy ribs are hinged to a central dish and folds towards the feed when stowed. Metallic mesh is attached between the ribs that approximate a parabolic surface. The ribs are opened by means of a 4 bar mechanism, for which, the motion is induced by a screw and nut mechanism driven by a motor. These types of antennas have a very high deployed natural frequency (15 Hz). However as antenna diameter increases the complexity 5m Radial Rib Antenna in mechanism increases due to multiple folding of the ribs. (Image from http://download.harris.com/app/public_download.asp?fid=463).

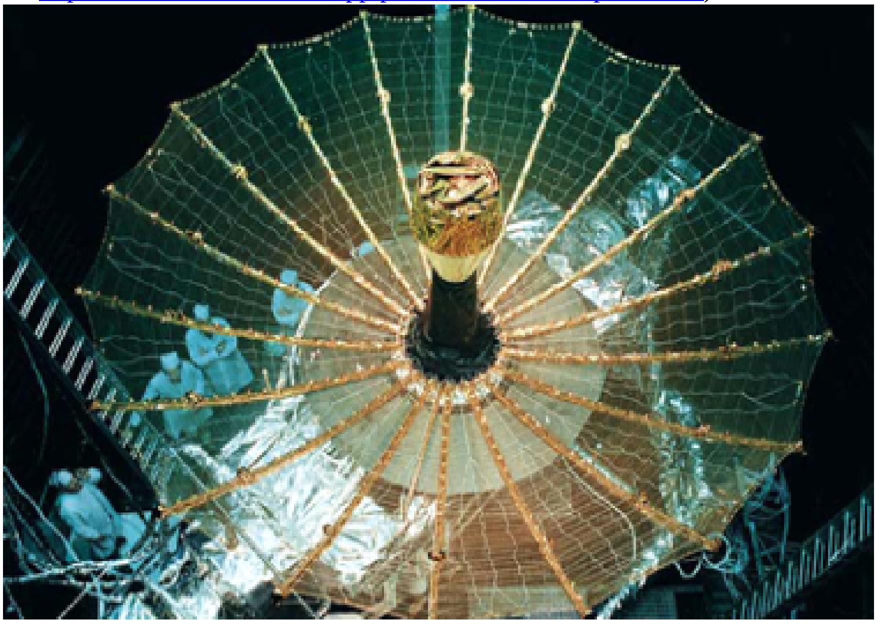
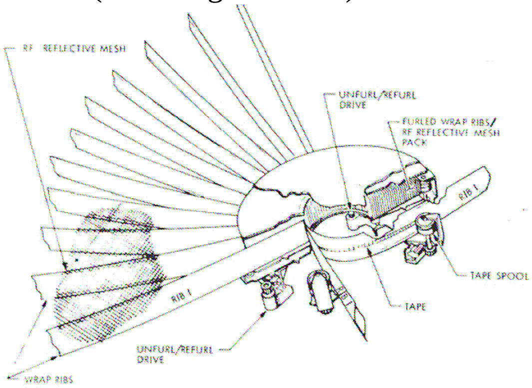


Fig. 1: 5m Radial Rib Antenna of Harris Corporation, USA

Wrap Rib Antenna: JPL and Lockheed Missiles and Space Company, USA developed the antenna in 1970s. In this parabolic antenna CFRP ribs of lenticular cross section and metallic mesh are wrapped around a central hub. The ribs are deployed by cutting a restraining cable placed around the hub. The stored energy in the ribs unwrap resulting in deployment. The deployment takes about two seconds. A 9.1 m diameter WRA was launched in 1974 with ATS-6 satellite. (Refer Figs. 2 and 3).



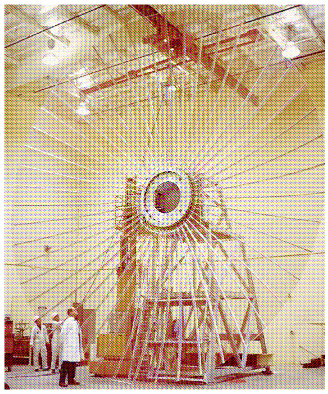


Fig.2: Wrap Rib Antenna mechanism (Exploded view) Fig3.: 9.1m Wrap Rib Antenna

(Reference: Satellite communications - Systems and its Design Technologies by Takashi Lida)

Tension truss antenna: This concept was developed by Miura in 1986. The reflector surface is approximated by a network of interconnected cables forming triangular facets. The advantage over rib antenna is that, the surface accuracy can be increased without increasing the number of supports. An outer deployable ring structure supports the cable net. The ring truss which is deployable is made of carbon composite tubes. Special joints ensure deployment synchronization. A 12.25 m diameter antenna developed by Astro Aerospace Corporation (Ref. Fig. 4) is now the current state-of-the-art unfurlable antenna which weighs 55kg.

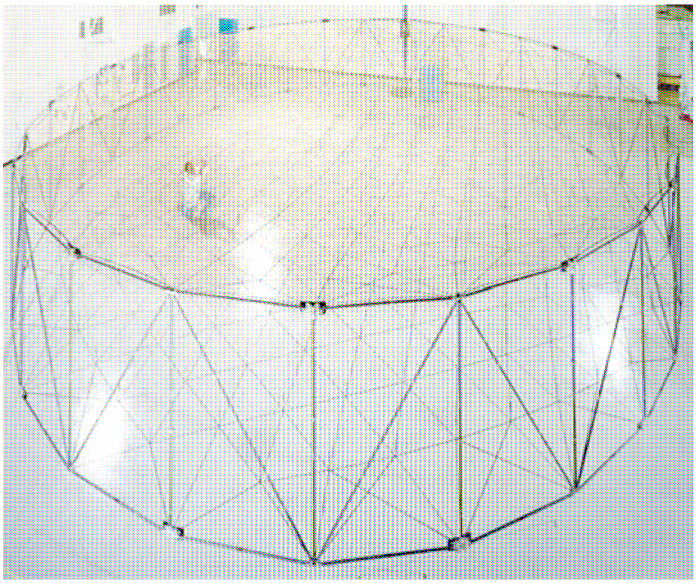


Fig4. Astromesh tension truss antenna

(Reference: http://www.st.northropgrumman.com/astro-aerospace/SiteFiles/docs/pdfs/DS-409-AstroMesh Reflector.pdf)

INSARM BANGALORE CHAPTER

NEWS

Seminar on Aerospace Mechanisms "Role of Robotics in Aerospace Applications", November 26, 2007



1. Dignitaries on the dais: Sri. VR Katti Programme Director GEOSAT, Dr. VK Aatre, Former Scientific Adviser to Defence Minister and Dr. PS Nair, President of INSARM Bangalore chapter
2. Keynote address: "Emerging Scenario of Battle fields" by Dr. V K Aatre
3. View of the Audience




1. 'Recent trends in Robotics for Aerospace applications' by Prof. K Kurien, IIT Mumbai.
2. 'Multi-axis motion control through digital servo technology' by Dr. R Sunder, BiSS Ltd.
3. 'Tribological aspects of space robotic systems and mechanisms' by Dr. V Krishnan, IISU/ISRO
4. 'Applications of MEMS for aerospace mechanisms' by Prof. G.K.Ananthasuresh, IISc Bangalore

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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