Indian National Society for Aerospace and Related Mechanisms

BANGALORE CHAPTER

E-NEWSLETTER

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From the Editor

It gives me immense pleasure to place before you this edition of E-newsletter. The first half of this year was a very significant milestone for the members of Spacecraft Mechanisms Group (SMG) at ISAC. With the on-orbit deployment of solar arrays onboard IRNSS-1F satellite, the mechanisms realized by SMG achieved 200 successive successful on-orbit deployments. In addition, they witnessed successful deployment and release of mechanisms onboard the remote sensing satellite CAROSAT 2C and navigation satellites 1G. The editorial committee congratulates the past and present members of Spacecraft Mechanisms Group, ISAC for this excellent achievement.

The article titled "*ROGER: ATerrain Generation Tool for Rover Mobility Simulation*" presents GUI based software that can be used to create custom terrains to simulate test conditions and to carry out the kinematic studies of rovers that can be used for interplanetary missions.

SMG celebrated the achievement of *200+ successive successful on-orbit deployments* at ISAC. The glimpse of this event is also presented in this 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:

"Imagination is most important than knowledge"

Albert Einstein

FROM INSARM BANGALORE CHAPTER

ROGER- A TERRAIN GENERATION TOOL FOR ROVER MOBILITY SIMULATION

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In the recent past there has been a growing interest among spacefaring nations to explore interplanetary terrains. The Moon is the first body in space, beyond Earth, that has witnessed a host of missions on its terrain. Missions to the Moon began with lunar flybys (Luna 1 in 1959), lunar impacts (Luna 2 in 1959), crashed landings (Ranger 4 in 1962, Luna 5 in 1965) and lunar satellites (Luna 10 in 1966).First lunar soft landing was successfully achieved by Luna 9 in 1966. The historical human landing of Apollo 11 in 1969 was a major milestone. First robotic rover Lunokhod-1 landed on the Moon in 1970 with Luna 17 mission. Space agencies of Russia, USA, Europe and Chinahave accomplished soft landings on lunar surface. India's upcoming Chandrayaan-2 mission will demonstrate the capability to carry out soft landing followed by rover based exploration. Mars, being our neighbouring planet has also received great attention in the exploration missions.Missions to Mars started off with Mariner-9 in 1971 which inserted first artificial satellite into mars orbit. First successful landings were carried out by Viking-1,2 missions in 1976 by NASA. After two decades, Pathfinder mission paved way for robotic ranging operations in 1997. Spirit and Opportunity rovers landed on mars in 2004 and have been sending detailed microscopic images of martian rock and soil. In August 2012, Curiosity rover landed on mars surface and is carrying out in-situ analysis of martian soil for organic compounds. India successfully inserted its orbiter into martian orbit on 24th Sep,2014 in its maiden attempt.

Inter-planetary rovers are required to provide robust mobility while traversing uneven and challenging terrains that in turn depends on the rover mobility system and wheel-terrain interactions. It is therefore important to ensure that the path rover traverses is hazard free by considering the wheel slip, sinkage, drawbar pull and drive torque requirements as it negotiates the terrain. Kinematic studies are also required toconfirm interference free movement of the rover suspension system and to ensure sufficient clearance between rover and terrain. Simulation of rover motion on virtual terrains provides a host of useful information in terms of likely rover performanceon terrain andprovides inputs for rover deisgn to achieve required performance. It also assists in real time control decisions like safe path planning and power estimation. However, it is also important that the findings from simulation are validated by rigorous testing on ground.

Figure 1 shows the typical steps involved in a rover motion simulation that involves modelling of rover geometry with necessary joint definitions, modelling of terrain, defining contacts between the interacting parts and applying motion to driving members.

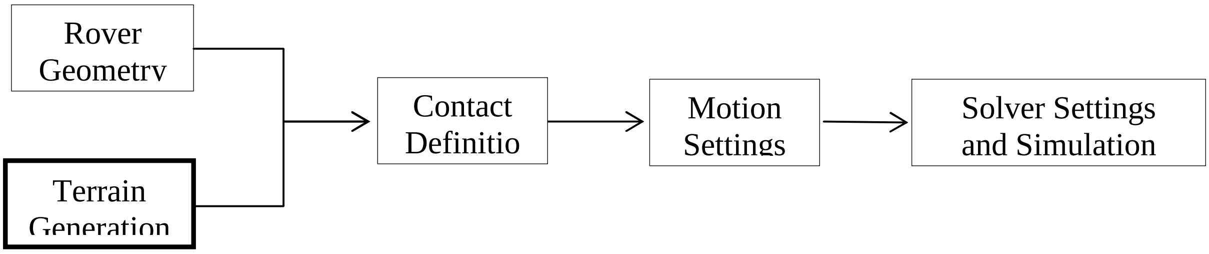

Figure 1: Typical rover motion simulation sequence

Taking a comprehensive view of the entire simulation process, it is observed that terrain generation through manual effort contributes a lot to the total modelling/simulation time. For terrains that are intricate and complicated, the time taken to generate the terrain tends to be much more than the solver time. Moreover, if the analysis is meant to support the rover motion in realtime, solution time becomes an important constraint in providing timely results.Terrain generation therefore offers a lot of scope for improvement in terms of total time elapsed for analysis. Considering above factors, a need was felt to develop a software tool that speeds up the terrain generation and makes the overall simulation more efficient.

ROGER (short for ROad GEneratoR) is a MATLAB based software that has been developed in house to automate the generation of virtual terrains. The tool can be used to generate user defined and Digital Elevation Map (DEM) based terrains. It allows the user to generate the terrain by specifying the number of segments and obstacles and the dimensions of each segment and obstacle (Fig.2).

At it's core, ROGERcreates nodes on the segments and implements a triangulation algorithm to build a triangular mesh.The nodes are created based on the spacing and dimension of each segment specified by the user. All nodes are numbered and theircorresponding x,y,z coordinates are stored in a matrix.To make the process more general, ROGER treats each segment individually and node numbering is also independent. The obstacles are then added on the identified segments and node coordinates are updated. All segments are then merged and nodes are renumbered to create a single matrix of node information. This node matrix is then used to create the triangular mesh. Fig.3 shows the software architecture.

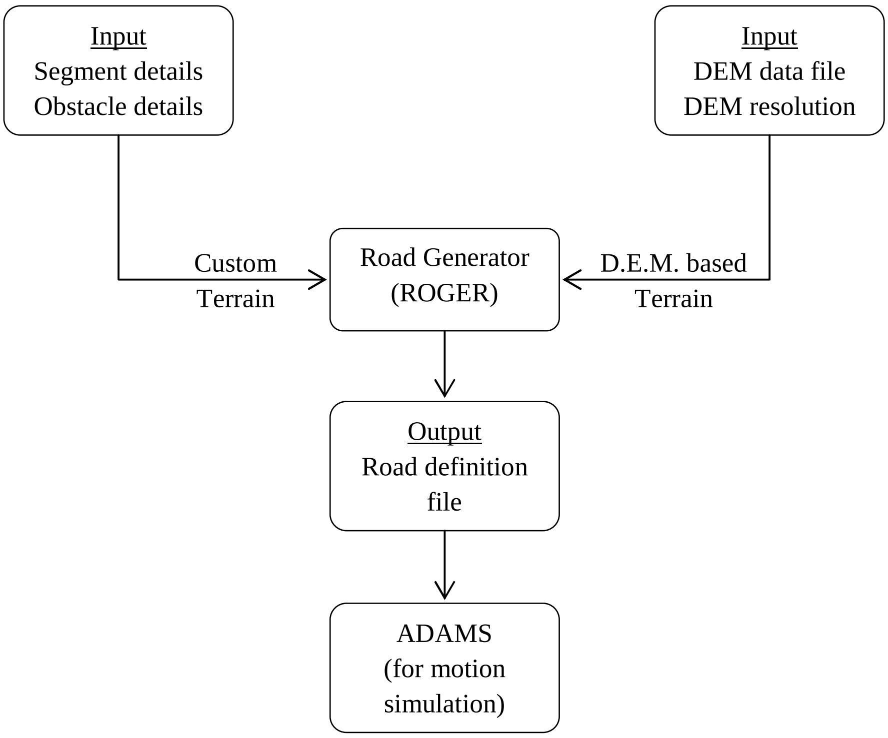

Figure 3: ROGER architecture

The node and mesh information is exported to a road definition file (rdf) and is imported into ADAMS multi body dynamics simulation software that is being used to simulate rover motion. An *rdf* contains the terrain information in the form of nodes and a triangular mesh.ROGER automates the creation of *rdf* and hence eliminates manual effort. Typical user defined terrains are shown in Fig.4.

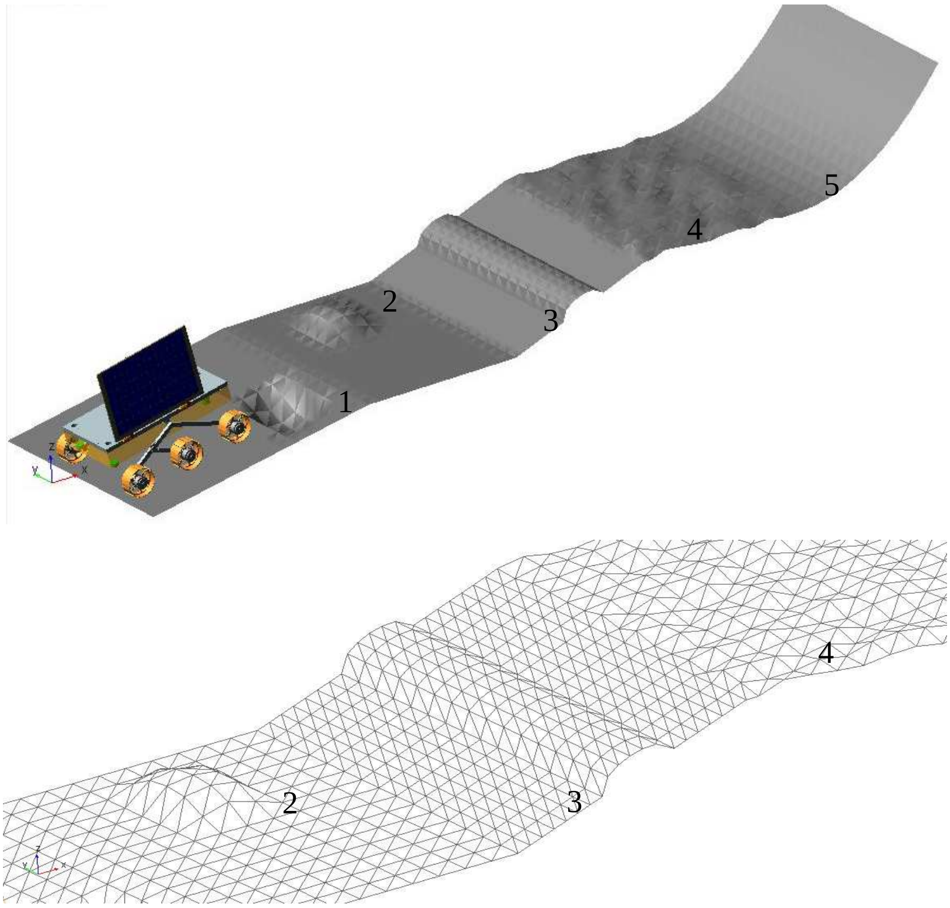

Figure 4: Custom terrain consisting of 1) ditch, 2) bump, 3) slope, 4) uneven, 5) parabola (above). Triangulation of data points (below)

Apart from generating user defined terrains, ROGER can generate terrains in real time for a rover traversing interplanetary terrain. Rovers use on-board navigation cameras to capture the heading surface that are processed to generate the Digital Elevation Map (DEM).For a DEM based terrain, ROGER skips node generation and uses the node coordinates available in the DEM file. Typical DEM based terrains are shown in Fig.5.

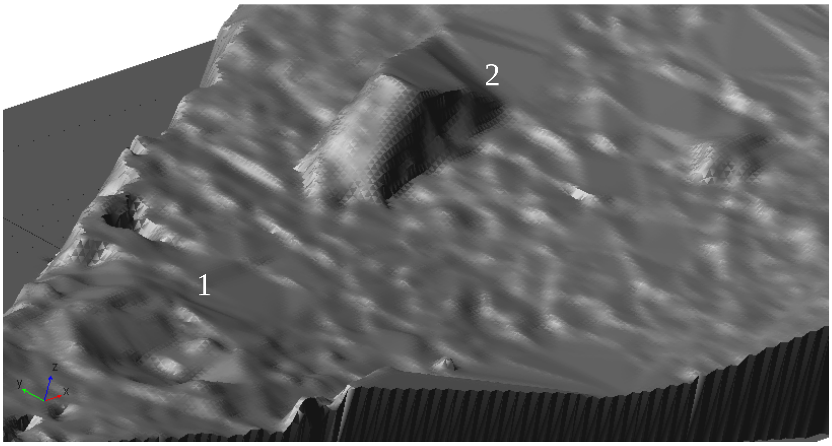

Figure 5: Typical DEM based terrain consisting of 1) Crater 2) Boulder.

In a nutshell, ROGER is a robust code to convert DEM data into terrains and to as well create custom terrains to simulate test conditions or carry out kinematic studies. The tool is developed with a menu based graphic interface and has eliminated the manual effort required for terrain generation.

SPACECRAFT MECHANISMS GROUP CELEBRATED 200+ SUCCESSIVE SUCCESSFUL ON-ORBIT DEPLOYMENTS

Spacecraft mechanisms group of ISRO Satellite Centre (ISAC), Bengaluru celebrated 200+ successive successful on orbit deployments. All the former employees, senior officials of ISAC and many other delegates including the present employees and project directors participated in the one day symposium on spacecraft mechanisms. As a part of the symposium presentations were made by Shri K A Keshava Murthy, Head, Mechanism Design and Development Division (Presently Group Director, SMG), Shri S Ravindran, Head, Mechanism Assembly and Testing Division and Shri H N Suresh Kumar, Head, Spacecraft Mechanisms Analysis Division. There was an elegant display of the flown mechanisms and as well as several developmental activities. The event also witnessed the release of Catalogue of Spacecraft Mechanisms Group. Glimpses of the event as given below:

Inauguration of the Symposium

Address by Director,ISAC

Felicitation of Shri M Nageshwara Rao

Felicitation of Shri C D Sridhara

Felicitation of Shri N Viswanatha

Panel Discussion

FORTH COMING SEMINARS

Advances in Robotics (AIR 2017)
3rd International Conference of Robotics Society of India
June 28-July 2, 2017
held at the Indian Institute of Technology Delhi, New Delhi, India

The conference website is http://www.advancesinrobotics.com

Full Paper Submission Deadline: Feb 1, 2017
Announcement of Results: April 10, 2017
Camera Ready Version: May 5, 2017
Conference: June 28-July 2, 2017

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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