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Study of Hypotenuse Slope of Chandrayaan-2 while Landing on the Moon Surface

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Abstract: Chandrayaan-2, a complex lunar mission, aimed to attain detailed scientific knowledge of the moon. The observations that would be provided by the Chandrayaan-2 would be helpful in finding the origin and evolution of the moon in a newer way. In this work a hypotenuse slope of Chandrayaan-2 is obtained and plotted using Chandrayaan-2 data obtained from online resource. The data has been tabulated and used to find the slope of Chandrayaan-2 while landing on the moon surface. The obtained slope is also compared with the Chandrayaan-2 down range.

Keywords: Chandrayaan-2, moon/lunar, hypotenuse, slope, vertical range, horizontal range, down range

I. INTRODUCTION

Chandrayaan-2 is a moon mission launched by ISRO to obtain the scientific information about the moon [1]. The main aim of the mission is to get the knowledge of moon origin and evolution with a newer understanding by targeting and exploring the lunar South Pole. In detail it would give the information of moon's tomography, minerals, surface chemicals, seismography, top soil thermo physical characteristics and atmosphere.

II. CHANDRAYAAN-2 SPACECRAFT CONFIGURATION

The Chandrayaan-2 consists of an orbiter, lander and rover as shown in fig. 1. It was launched using the GSLV Mk-III, India's most powerful launcher which is completely designed and fabricated in India. The launcher is a three stage space vehicle. It has capability of launching four ton class of satellites into the GTO. The function of the orbiter is to observe the moon surface and relay communication between the Earth and the Chandrayaan-2 lander named "Vikram". The function of the Vikram lander was to ensure the smooth landing. The Rover named "Pragyan" is a six wheeled and Al-powered. The rover is to move around the surface of the moon and give the lunar information [1-2].

Fig. 1 Chandrayaan-2 Spacecraft Configuration [2]

TABLE I
CHANDRAYAAN-2 SPACECRAFT CONFIGURATION DETAILS

Parameter	Configuration		
	Orbiter	Lander	Rover
Weight	2,379 kg	1,471 kg	27 kg
Electric Power	1,000 W	650 W	50 W

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III. Data Acquisition & Results

The data [3] has been acquired from online resource and tabulated. The following parameters have been tabulated,

- Time (sec)
- Horizontal range (m/s)
- Vertical range (m/s)
- Down range (kms)

From the acquired data, 14 seconds (10 to 10.13) of the data is considered for the illustration and analysis. The concept of Pythagoras Theorem [4-5] has been used for obtaining the slope. The concept is well suited as the horizontal range can be considered on the adjacent side and vertical range on the opposite side, making us easier to obtain the slope i.e. hypotenuse as shown in fig. 2.

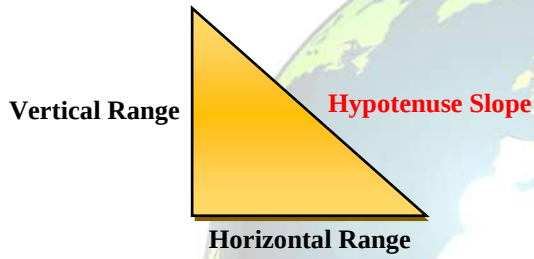

Fig. 2 Implementation of Pythagoras Theorem on Chandrayaan-2 Data

The hypotenuse slope is obtained using the equation,

$$Hyp/Slope = \sqrt{HR^2 + VR^2} \quad (1)$$

where,
Hyp is the hypotenuse
HR is the vertical range
VR is the vertical range

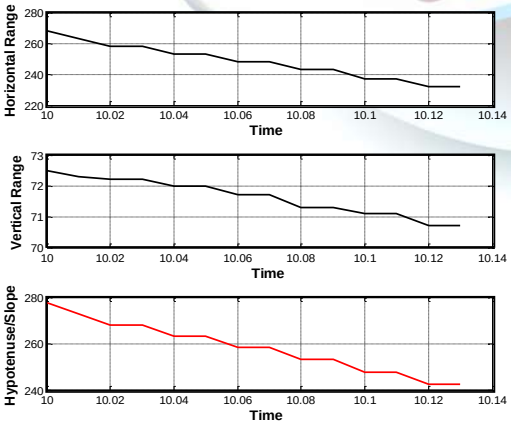

Fig. 3 Variations of Horizontal Range, Vertical Range and Hypotenuse/Slope of Chandrayaan-2 while landing on moon

TABLE 2
MAXIMUM, MINIMUM, MEAN & STANDARD DEVIATION VALUES OF CHANDRAYAAN-2 PARAMETERS

Parameter	Max.	Min.	Mean	Std. Dev.
Horizontal Range (m/s)	268	232	248.0714	11.3643
Vertical Range (m/s)	72.5	70.7	71.6286	0.5980
Hypotenuse/ Slope (m/s)	277.633	242.533	258.2175	11.083

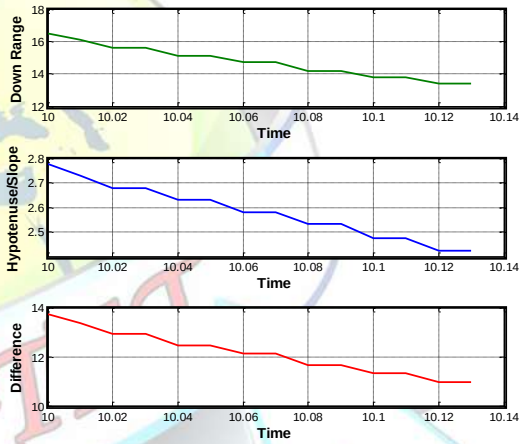

Fig. 4 Variations of Down Range, Hypotenuse/Slope and Difference between Down Range and Slope of Chandrayaan-2 while landing on moon

TABLE 3
MAXIMUM, MINIMUM, MEAN & STANDARD DEVIATION VALUES OF DOWN RANGE, HYPOTENUSE/RANGE AND THEIR DIFFERENCE

Parameter	Max.	Min.	Mean	Std. Dev.
Down Range (kms)	16.5	13.4	14.7286	0.9856
Hypotenuse/ Slope (kms)	2.7763	2.4253	2.5822	0.1108
Difference (kms)	13.7237	10.9747	12.1464	0.8750

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Fig. 3. Show the variations of Horizontal range, vertical range and the obtained hypotenuse/Slope. Table 2 show the maximum, minimum, mean and standard deviation of the above parameters. Apart from these analysis comparison between hypotenuse/slope and down range from the data is also compared as shown in fig. 4. and their maximum, minimum, mean and standard deviation values are been tabulated in table 3.

IV. CONCLUSION

The hypotenuse/slope of the Chandrayaan-2 has been successfully obtained while landing the lunar surface. The hypotenuse slope analysis show that the Pythagoras Theorem algorithm was a well suited as with the availability of horizontal and vertical ranges from the data. This showed that the horizontal range measured values are much nearer to the slope when compared to the vertical range. The difference in standard deviation between the horizontal range and slope range is 0.28 m/s. This closeness might be a helpful predication in robust/rough estimation during a scenario like this. Down range data was also considered for the analysis. The down range in kms was compared with the slope in kms. No significant observations were observed from the values but the trajectory graph was observed to look similar to the down range.

FUTURE SCOPE

Study analysis of this kind would be helpful in working with real time data science aspects and basic algorithms might also produce required or supporting requirements for a research.

REFERENCES

[1]. https://www.isro.gov.in/chandrayaan2-home-0.

[2]. https://directory.eoportal.org/web/eoportal/satellite-missions/c-missions/chandrayaan-2.

[3]. https://www.youtube.com/watch?v=2srV-bEi_DU.

[4]. CzesławBuraczewski and Jan Stasiek, "Application of generalized Pythagoras theorem to calculation of configuration factors between surfaces of channels of revolution," Elsevier International Journal of Heat and Fluid Flow, Volume 4, Issue 3, September 1983, Pages 157-160.

[5]. Elif Seyitoglua, Kübra Akkaya, Cemalettin Yildiz, Selahattin Arslan and Serkan Çostu, "Students' views about activities developed on the history of Pythagoras' theorem," Elsevier Procedia Social and Behavioral Sciences 15 (2011) 882–886.

BIOGRAPHY

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