UNIVERSITI TEKNOLOGI MARA

DESIGN OF LOW GROUND SAMPLING DISTANCE (GSD) IMAGING SYSTEM PAYLOAD FOR 1U-SIZED CUBESAT APPLICATION

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ABSTRACT

The attributes of 1U CubeSat which are small mechanical size, light in weight, and low power supply, have been the constraints for selecting an imaging mission system. As the result, 1U CubeSat is usually attached with an imaging sensor that suits based on its limitations without putting the high-resolution imagery as a vital consideration. Imaging system with high number of pixels that produces high resolution imagery requires high power and usually comes in bigger size due to the outrages processing requirements. To solve the issue, an imaging system with high ground resolution that is associated with low ground sampling distance (GSD) was designed to be practical for the application of 1U CubeSat. To strategize the design and development of the imaging system, the main components of the imaging system were optimally and feasibly chosen based on 1U CubeSat's derived limitations, followed by selection of suitable optical device with longer focal length that contributed to lower GSD value, and verification of space application and imagery output in terms of GSD. As the BIRDS CubeSats Project was considered as reference for its space heritage, the space application was set at 380 to 400 km working distance, and thus, 16 m GSD imagery was acquired when the selected 5 MP CMOS imaging sensor was applied with 35 mm focal length lens. The result led to the small swath area that allowed the imaging sensor to focus on the small element of the target area. The functionality, integration, and space environment tests were successfully performed to ensure the develop imaging mission system was qualified for space application. As for imagery validation through RGB and SNR analysis, it showed that the distribution of red colour decreased including the SNR with the implementation of IR Cut Filter that removed IR ray from entering the imaging sensor. This research proved that 1U-sized CubeSat was capable of having a high ground resolution imaging system when the GSD was reduced through the focal length of the optical lens. The works have contributed to the multination collaborative ASEANSAT project which was the continuation of 1U CubeSat development in Malaysia.

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CHAPTER ONE
INTRODUCTION

1.1 Background of Study

1.1.1 The Genesis of a CubeSat

Small satellite is a type of artificial spacecraft that is smaller and lighter than commercial or conventional satellite in space. Nanosatellite and CubeSat are the examples of the small satellite. Commonly, these two (2) terms are used interchangeably mostly in informal conversation. To be precise, CubeSat falls under the class of Nanosatellite, while Nanosatellite is categorized as a small satellite as described in [1], [2]. Satellites are classified based on their mass and size as listed in Table 1.1.

Table 1.1
Categories of Satellite. Source from www.cubesat.org, , [2], [3], [4]

Category	Class	CubeSat Standard Name	Mass (kg)	Size (cm)
Small	Femtosatellite		~ 0.01 – 0.1	
	Picosatellite		~ 0.1 – 1	
	Nanosatellite		~ 1 – 10	
		1U	1 – 1.33	10 x 10 x 11.35
		2U	2 – 2.66	10 x 10 x 22.70
		3U	< 4	10 x 10 x 34.05
	Microsatellite		~ 10 – 100	
		6U	< 12	20 x 10 x 34.05
		12U	< 24	20 x 20 x 34.05
		27U	< 40	
	Minisatellite		~ 100 – 500	
Medium			~ 500 – 1000	
Large			1000 – 5000	
Extra Large			>5000	

CubeSat was proposed by a researcher named Professor Emeritus Bob Twiggs from Stanford University, California [5], along with his co-researcher, Professor Jordi Puig-Suari from California Polytechnic State University in 1999 [6], for the purpose of