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CUBEOS: A PX4 AUTOPILOT-INSPIRED FLIGHT SOFTWARE FOR NEPAL'S
NEXT-GENERATION CUBESAT BUS

Abstract

With the introduction of CubeSat specifications in 1999, CubeSat has become a new de-facto standard to go for when developing nano-satellites. What was initially only used by research institutions for technology demonstration and educational institutions for research and education has become a commercial hit and success with multiple space start-ups and companies investing in providing CubeSat-based space solutions. This is more so for the last decade which saw almost 1500% rise in CubeSats launched compared to a decade ago in 2013. This is even more useful for designing low-earth constellations with a short lifetime, providing near-earth space solutions and services. While CubeSat has been a cost-efficient tool for space systems, the lower success rate of only 29% and longer development cycle compared to orbit life poses a challenge for new players in the field. This is especially true for countries such as Nepal, with limited resources, requiring rapid development and deployment cycles with higher success rates.

This paper proposes a novel standard CubeSat bus, based on software-based hardware design methodology. The bus developed in-house by Antarikhya Pratisthan Nepal (APN), NEXT_GEN_CUBUS, features a single-board bus system, with an on-board computer (OBC), Electronic Power Supply (EPS), and Communications System (COM) all-designed within a 65x65x9 mm³ board. The core of the system is a flight-proven STM32F4 MCU series, running at 168 MHz, running CubeOS APN's general CubeSat flight software designed based on PX4 Autopilot. PX4 Autopilot is a mature, highly popular, and open-source, community-driven drone flight software. PX4 Autopilot adopts an easy-to-use modular architecture making it highly configurable without the need to change the firmware. This makes it extremely suitable to be used as a repurposed CubeSat operating system, CubeOS. This allows the developers to leverage the existing PX4 Autopilot community to get support in case of bugs in the system, which in turn expedites the development process. The modular feature of the software simplifies the addition of new devices and support for the mission. CubeOS in conjunction with the bus hardware allows for a 30% improvement in satellite readiness timeline, including ample time to run through tests for increasing survivability and adaptability in space. CubeOS is designed to be used in plug-and-play satellite systems along with NEXT_GEN_CUBUS for rapid development and deployment of satellites, especially for real-time data collecting constellation for Nepal.