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CUSTOM-BUILT ON-BOARD COMPUTER FOR METUCUBE SATELLITE

Abstract

METUCube is a 3U CubeSat developed by students at Middle East Technical University (METU), marking the university's first student-designed satellite. The primary mission objectives of METUCube are post-disaster monitoring and the evaluation of early warning systems. To fulfill these objectives, the satellite is equipped with multispectral and thermal cameras as its primary payloads.

The On-Board Computer (OBC) in a CubeSat acts as a bridge which connects every part of the satellite together. In this paper, a Linux-based, non-real-time flight software which runs on a Raspberry Pi embedded system is discussed in detail. A flight software, which runs based on NASA cFS (core Flight System), is also proposed and explained.

The aim for the research in this paper is to develop an OBC system, which is easy to customize and develop for different CubeSat missions with high production speeds. Thus, a software framework that can be adapted to different mission profiles is needed. NASA's cFS framework is explained throughout the paper with its high adaptation features, and the different options to customize are also discussed.Various flight software structures built on cFS are compared, highlighting their benefits for different mission types. Housekeeping management, memory limitations, mastering an attitude determination and control system, bootloading, and watchdog timers are explained with the real life use cases.

This mission's primary payload is a camera system. Raw image processing, high speed inter data transmission, and large size data storage options are explained in detail. In addition to the image communication interfaces, the intercommunication of OBC with different dedicated computers, such as power computers or ADCS computers, is also analyzed and compared through different communication interfaces such as SPI, I2C, CAN, and UART.

The Raspberry Pi Compute Module is selected as the main embedded system to develop the flight software on top of. Due to its cheap price, high accessibility around the world, and proven success of Raspberry Pi products, Raspberry Pi Compute Module is a great option for OBCs, specifically for CubeSat missions.

In the paper, different benchmarks for the embedded system are also analyzed, along with the radiation and power consumption tests, which are the main concerns for high power microprocessors such as the Raspberry Pi Compute Module.

In the project, team members are all involved in different parts of the project. Tasks are divided as flight software architecture design, intterrupt managing, operating system managing, and payload processing.