The on-board software of spacecraft is vital in its operation. Without it, a spacecraft would simply be a collection of hardware, drifting through space, and achieving nothing. CubeSats, a type of nanosatellite, are no exception. The goal of this project is to continue the software development of KeydetSat-1, a 3U CubeSat under development at the Virginia Military Institute, and begin integrating the subsystems into the software architecture. This project built upon the work done by Cadet Timothy Hayes, ’19 and Colonel Gerald Sullivan, and the 2020 KeydetSat Capstone group, Cadets Trevor Amato ‘20, Aaron Barraclough ‘20, and David Tolley ‘20, and Colonel Joseph Blandino. The main objective is to have the software operate the motion of a motor that extends and retracts a composite boom, the scientific payload of the spacecraft. A multitude of software development tools, both physical and digital, were used to construct the program. The functionality of the boom was tested and verified in order to begin integrating it with other components and having the microcontroller control the entire operation.

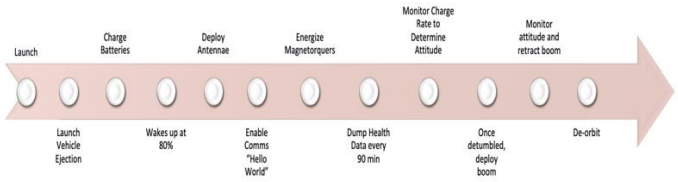

Figure 1: Mission Plan

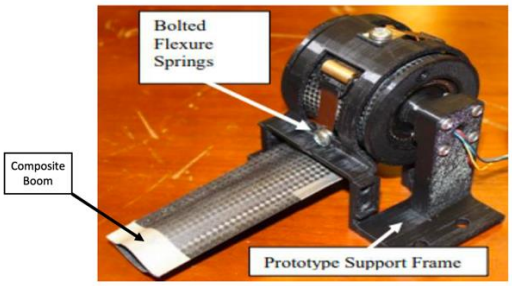

Figure 2: Boom Deployment Mechanism

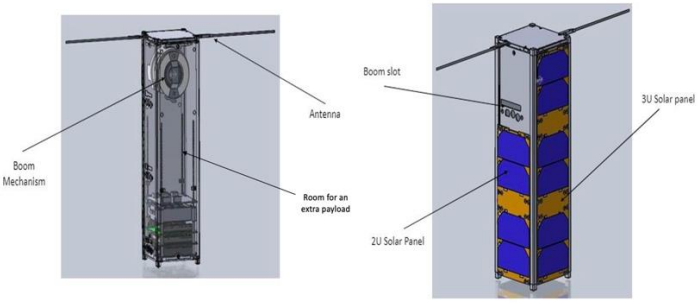

Figure 3: External & Internal View of KeydetSat-1

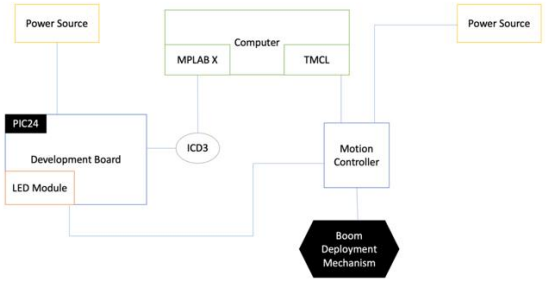

Figure 4: System Interface Schematic

Over the Summer and Fall of 2021, and Spring of 2022, the architecture of the Real Time Operating System (RTOS) enabled software was established and optimized. The main scientific payload of the spacecraft is a composite boom deployment mechanism. Composite booms are an enabling technology for many devices such as power-delivering solar arrays, communications antennae, gravity-gradient stabilizers, and drag sails. The booms are typically stowed in a coiled configuration prior to launch and deployed once the spacecraft reaches orbit. A program was developed to control the scientific payload, through the communication of two different embedded microcontrollers. Research was also conducted into the elimination of slippage in the boom deployment mechanism to ensure mission success, and the establishment of drivers and their relationships to the tasks they support. The tasks correlate to the operation of the various subsystems on board the spacecraft. These include communications, power management (EPS), an attitude determination and control system (ADCS), telemetry, track and command systems

(TT&C), the command and data handling protocols (C&DH), and the main mission payload. This software foundation exists as a sturdy platform upon which future CubeSat project cadets can make rapid strides into fleshing out a final program.

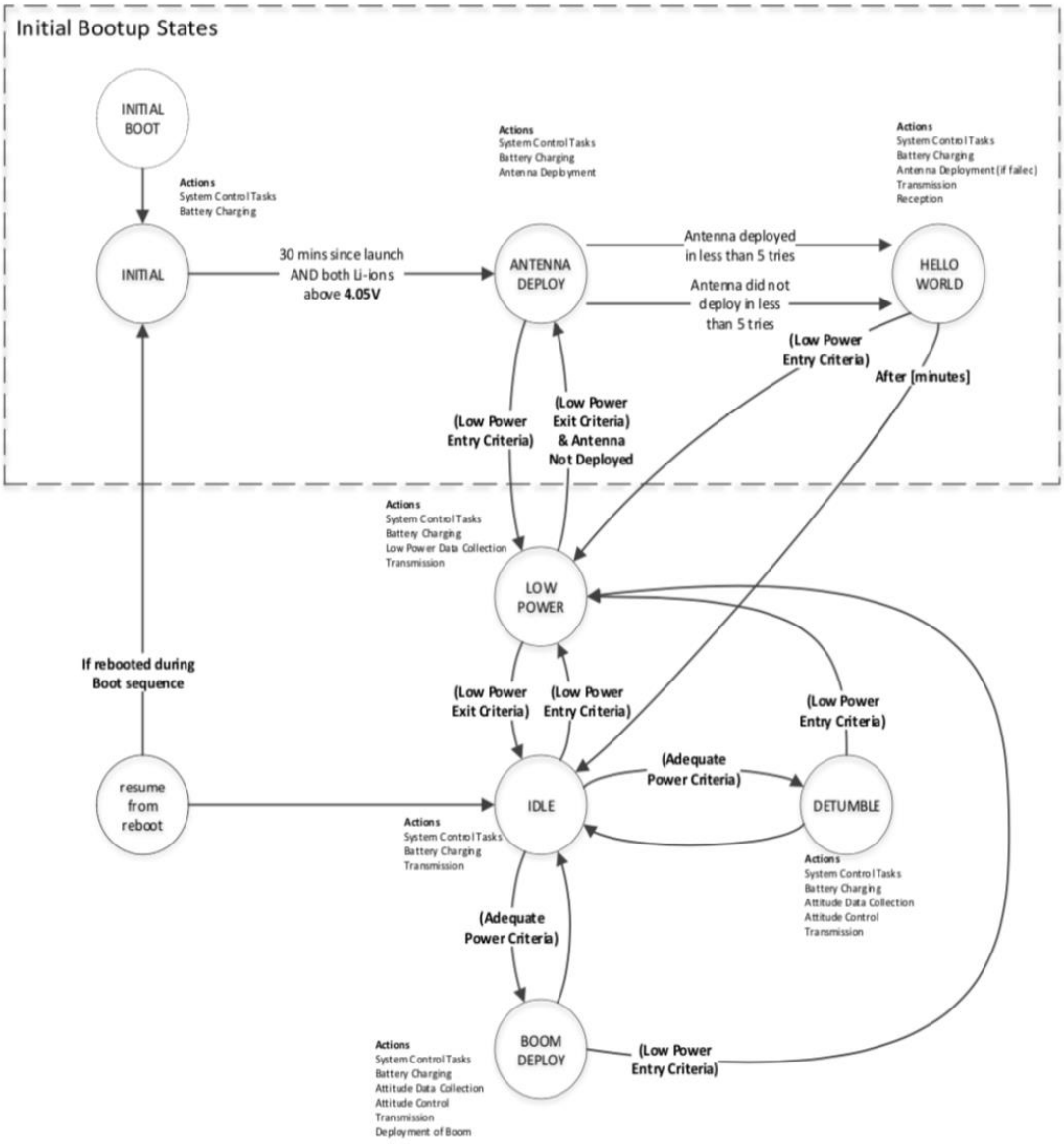

Figure 5: State Machine Diagram of CubeSat Operation