

A View from the Southern Hemisphere: Space Research at Stellenbosch University

ADCS for a PocketQube Satellite - SUNQube 1 (Jandr )

Simulation, hardware, and software development

Hardware: Momentum Wheel, Magnetorquers, OBC, Sensors

Validation and testing of full ADCS system

Designed for a **3P PocketQube** platform



SUNQUBE 1

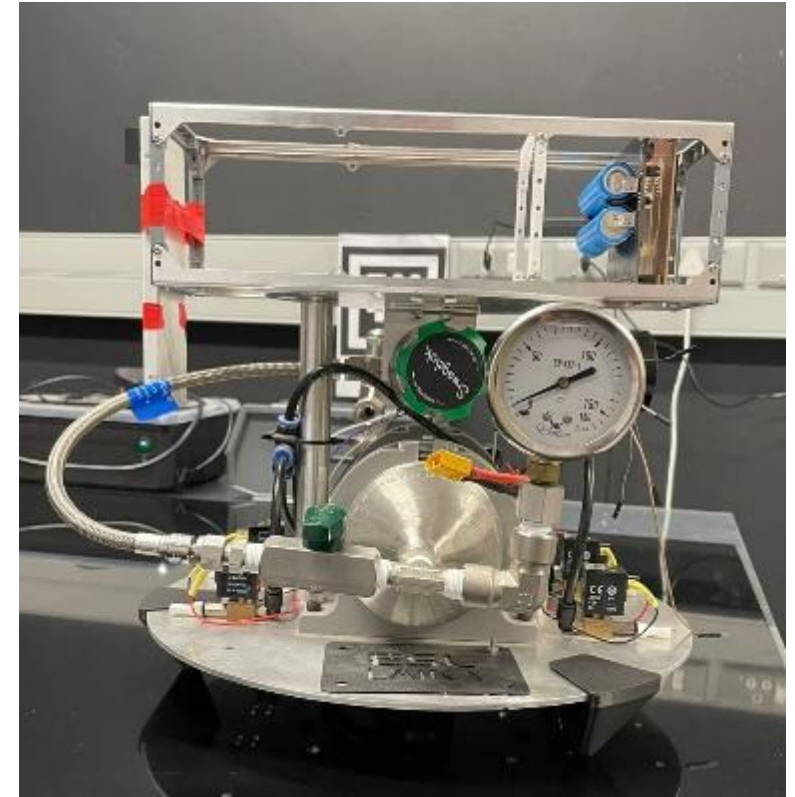
Close Proximity Control Docking of CubeSats to Moving Target - DockSat Mission (Russouw)

Improved docking adapter for flight-ready prototype

Thruster-based control system development and testing

Tested on **air bearing table** with mobile trolleys

Enables **CubeSat docking/undocking** with a moving target



Trolley Test

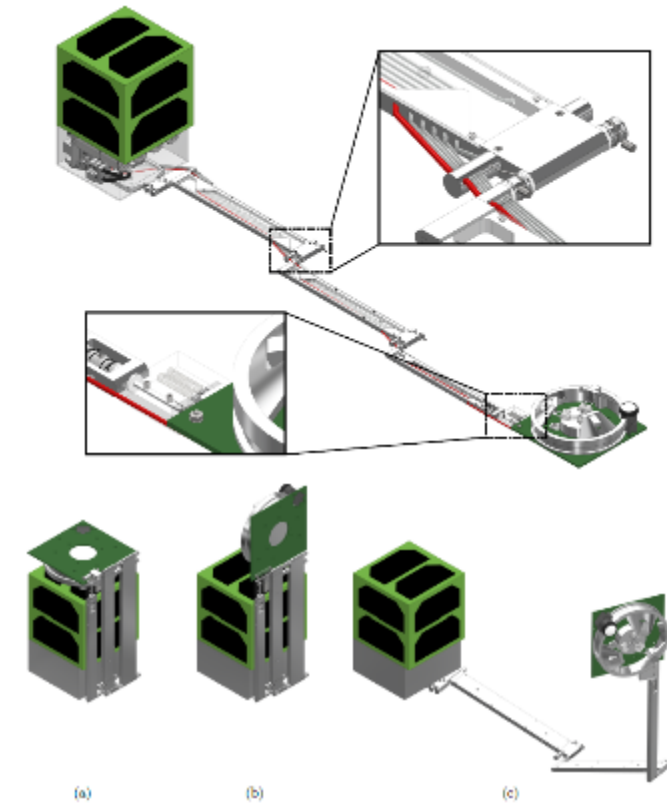
Robotic Arm - DockSat Mission (Dane)

CubeSat: Nanosatellite made of 10 cm x 10 cm x 10 cm Units (U)

On-Orbit Activities: On-Orbit Servicing, Repairs and Assembly.

Manipulator: Series of links rigidly connected by joints. Series of joints articulate together to enable an end-effector to move and interact with objects in space.

DockSat: a mission within the university to develop and miniaturise the technology required to enable docking between nanosatellites.



Full Arm Design

FPGA-based Star Tracker Camera for a PocketQube Satellite (Nortier)

Image capture and processing on FPGA hardware

Star detection and centroiding algorithm development

Star pattern identification for attitude estimation

Calibration and validation through ground testing



Star Tracker Camera Example - Sodern Auriga

Design of a Radiation Hardened CubeSat OBC (Michael)

RISC-V based CubeSat

OBC design

Focus on radiation tolerance

Single Event Effect testing

Apply hardening techniques

Propose architecture improvements



CubeSat OBC Example - ISIS Space

Wireless CubeSat System for Agricultural Monitoring (Mayameko)

Combines IoT ground sensors with CubeSat imaging

Provides data on crop health, soil, and environment

Uses **Meshtastic mesh network** for ground communication

Gateways connect to satellite via **modified TDMA**

Aims to **improve farming efficiency and resilience** in Africa

Propose architecture improvements



SUNQUBE-0B

ADCS for a Moon-Orbiting Satellite (Petrus)

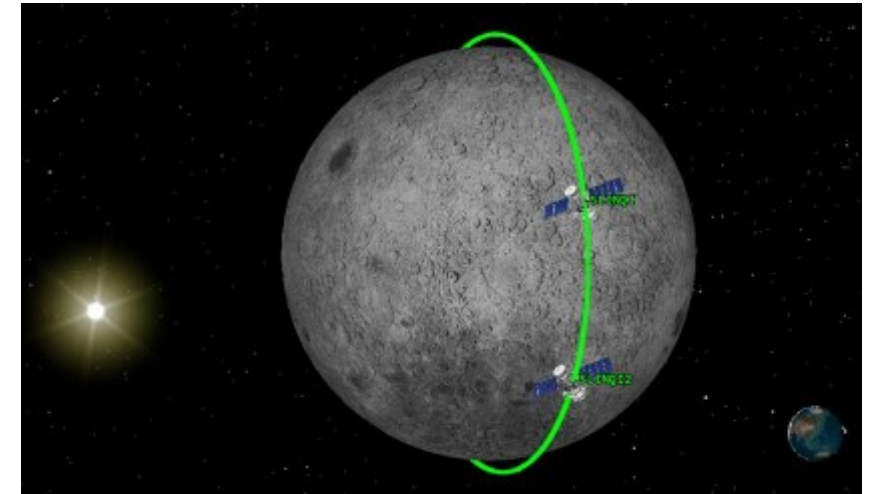
Develop control algorithms for lunar orbit ADCS

State estimation and system-level development

Embedded implementation with testing and simulation

Hardware-in-the-loop (HIL) validation

Includes lunar orbit propagation and position estimation



Ansys STK Lunar Orbit Simulation

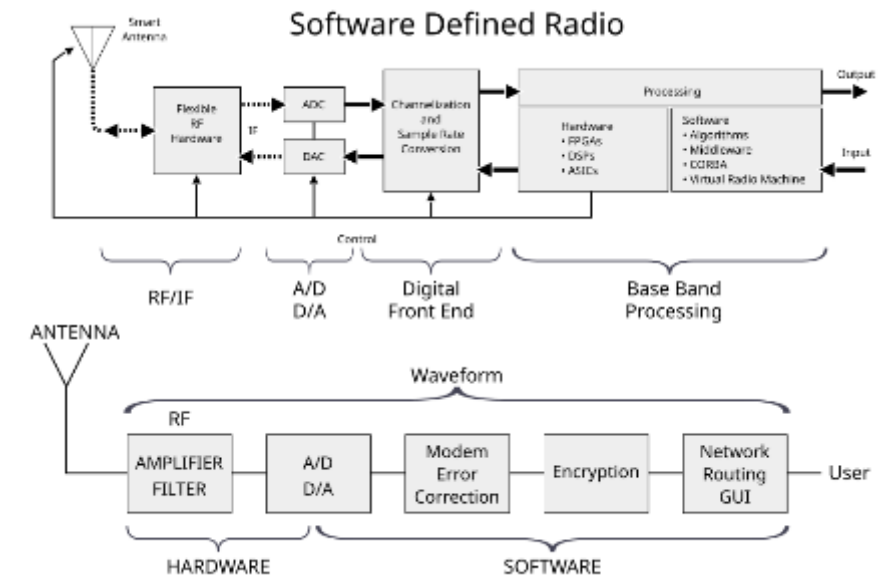
Software defined Radio (SDR) on an FPGA (Sazi)

FPGA-based SDR transceiver for satellite communication

Automatically switches modulation and encoding based on BER

Ensures robust links over varying signal conditions

Research involves hardware implementation, real-time signal processing, and adaptive algorithms



Flight Control System for a Suborbital Sounding Rocket (Jonno)

Develops **guidance and control** for suborbital rocket trajectories

Simulation environment models rocket dynamics and atmosphere

Designs and tests **robust controllers and state observers**

Implements **flight computer** for real-time control laws

Validated through **Hardware-In-The-Loop (HIL) simulation**



Example - ASRI Phoenix-1D rocket by UKZN

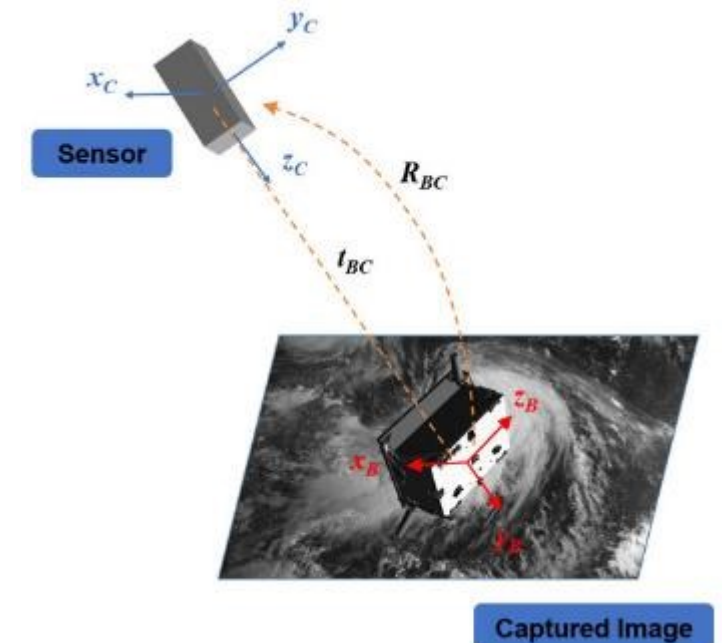
Full State Pose Estimation using a Satellite Imager (Neil)

Uses **Earth observation camera** for position and attitude estimation

Visual navigation matches Earth features to known maps

Enables **absolute pose determination** from onboard imagery

Forms the basis of an **Earth Tracker sensor** for satellites



Pose Estimation by R. Ye, Y. Ren, X. Zhu, Y. Wang, M. Liu, and L. Wang

Thank you
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