Master's Thesis Engineering Technology

2020-2021

Embedded control software for OSCAR-QUBE sensor: subsystem control and data acquisition synchronization

Vanspauwen Sebastiaan

Master of Electronics and ICT Engineering Technology

Introduction

Within the thesis the embedded control software for the OSCAR-QUBE sensor is developed, which is a diamond-based magnetometer that uses the NV center point defect. The sensor requires a microwave, laser and readout control. For this, a power board for the cube is designed on which the control subsystem is present. The board also includes the reference subsystem, data storage subsystem and FPGA subsystem. The thesis is part of "Orbit Your Thesis" Programme by European Space Agency, in which the sensor will measure for four months onboard the International Space Station in the ICE Cubes Facility.

Objectives

- Develop embedded software for all subsystems using a Real-Time Operating System
- Design control system Printed Circuit Board (PCB)
- Verify correct operations of the sensor
- Synchronize data acquisition and storage
- Create organized data packets

Design

Figure 1: Whole OSCAR-QUBE stack

Subsystems

- Storage subsytem
- Reference subsystem
- Control subsytem
- FPGA subsystem

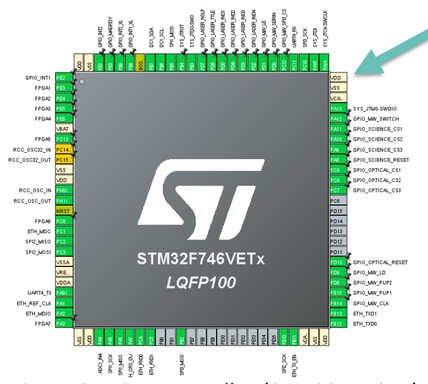
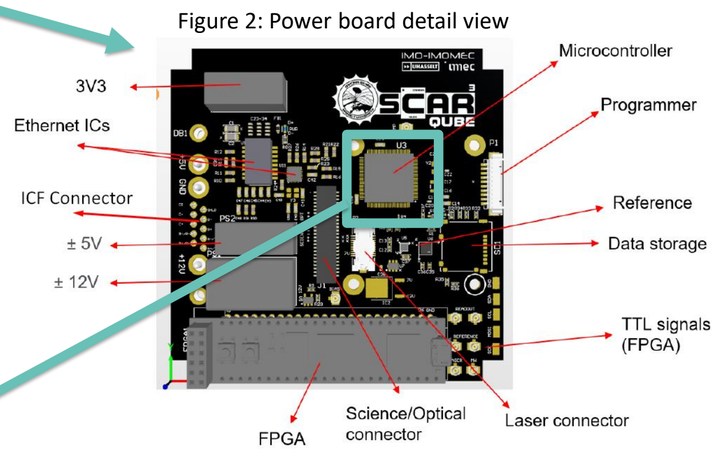


Figure 3: microcontroller (STM32F746VE) pinmapping

Power board location

- Whole sensor contains four PCBs
- Power board is bottommost board
- Contains ICF connector which provides Ethernet and power
- Connectors provide voltages and signals to upper boards

Figure 2: Power board detail view



Control subsytem

- Real-time parameter changing and feedback over Ethernet
- Control all systems using a single microcontroller with RTOS

Results

Various operational modes and settings possible

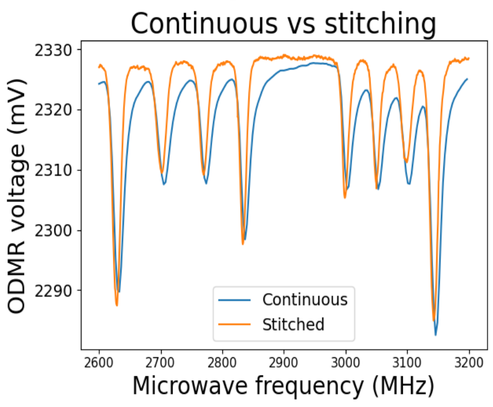


Figure 4: Continous versus stitching operational mode

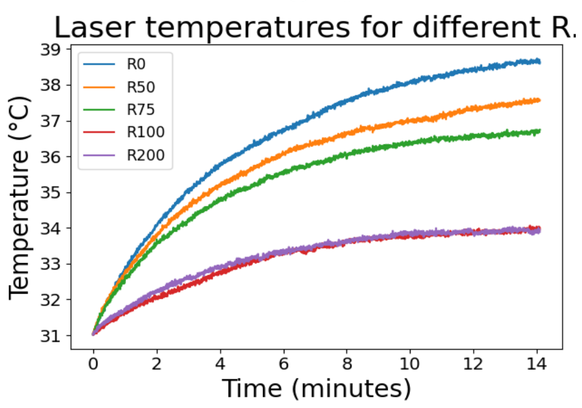


Figure 5: Different laser strength heating graphs

Connection loss detection

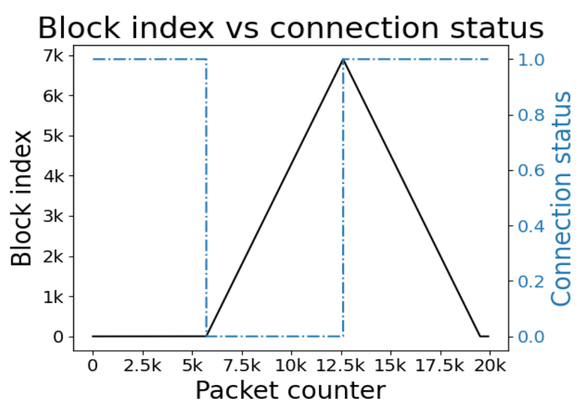


Figure 6: SD-card storage in case of connection loss

Succesful integration within "Orbit Your Thesis" Programme

Figure 7: OSCAR-QUBE mounted on ground copy of ICE Cubes Facility

Power board passed interface test

- Inrush current
- Ethernet communication
- Remote commanding through ICE Cubes Mission Control Centre
- Autonomous operation

Conclusion

The design process of the thesis was completed successfully, and the aim of the thesis is achieved. The power board fulfilled all the required roles within the thesis and passed all the tests including the critical ones, and the software has all the required functionalities to operate the system remotely via Ethernet commanding

Promotor: Prof. dr. ir. Ronald Thoelen
Co-Promotor: Prof. dr. Milos Nesladek
Work supervisor: Ir. Jaroslav Hruby

Sebastiaan Vanspauwen
https://www.linkedin.com/in/sebastiaanvanspauwen
Master of Electronics and ICT Engineering Technology