Miniaturization of an Autonomous Sensor Node

Degree programme: BSc in Electrical- and Communication Engineering | Specialisation: Embedded Systems
Thesis advisor: Dr. Torsten Mähne, Ivo Adrian Oesch
Expert: Michael Held (Bystronic Laser AG)
External project partner: ETEL S.A., Môtiers

Knowing the experienced operating conditions of a returned electrical motor provides precious insight to its manufacturer. This helps to understand its long-term behavior and thus to improve its quality. A miniaturized data logger, based on the findings from a previous developed prototype, has been realized for such use cases. A modular software including data protection and power management guarantees a proper operation.

Introduction

The company ETEL S.A. produces torque motors and linear motors, which are used in a big variety of positioning and motion systems with nanometer precision and high forces and dynamics. To improve the product's quality, it is helpful to know the history of experienced operating conditions. Therefore, an autonomous data logger shall log, in agreement with the customer, the operating hours and other physical quantities inside the motor. In a previous thesis, a working prototype has been developed and tested. The data logger has to tolerate temperatures up to 120 °C and strong disturbing electrical and magnetic fields for a lifetime of 10 years.
Goal of this project was to improve and miniaturize the prototype.

Concept

A new specification sheet has been composed based on an analysis of the previous thesis and further input from ETEL S.A. The data logger is powered by a thermoelectric generator to ensure galvanic isolation and autonomous operation. The firmware logs operating hours, humidity in the potting and temperatures from three sensors at different positions. The logged data are stored in a ferroelectric RAM, which tolerates frequent writing cycles. Additional long-term statistics are stored into a flash memory with higher capacity.

To guarantee data integrity, the stored data is protected with a checksum. The logger's firmware monitors the supply voltages to guarantee a proper shutdown without data loss.

Realization

The newly designed semi-flex circuit board (see Fig. 1) integrates all functions of the previous prototype and the new specifications into a smaller form factor, fitting entirely into the potting of a big variety of motors. The implemented firmware is built up on the STM32CubeL0 hardware abstraction layer and uses the FreeRTOS operating system (see Fig. 2) to provide expandability. First short-term tests of the data logger and its firmware have been successful. All hardware and firmware components are working reliably.

Outlook

The next step will be tests to verify the long-term reliability of the data logger. During this thesis, it was demonstrated that electrostatic stray fields are a promising additional energy source, which could be exploited in the future. The firmware could be further improved in the areas of power management and data compression.

Roman Bärtschi
baerom@hotmail.de

Tobias Jared Batt
t.batt@gmx.ch

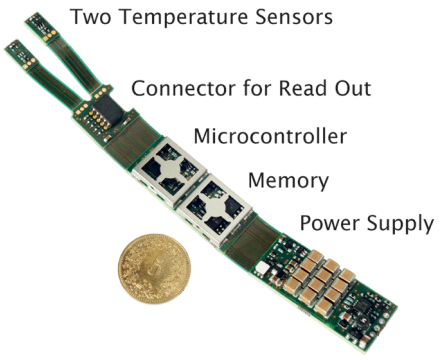

Fig. 1: The implemented data logger compared to a 5 cents coin.

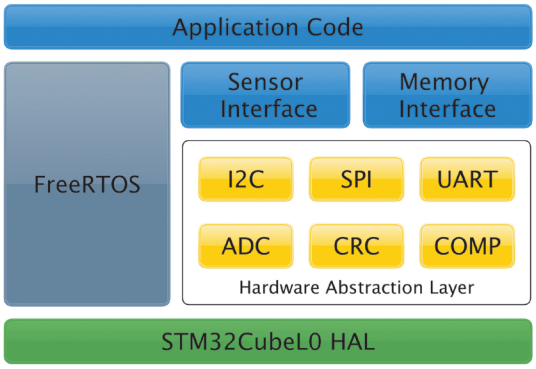

Fig. 2: Firmware architecture with the used peripherals.