CAN-based drive control for a robotic manipulator

The Homer project (highly-redundant, modular robotic systems for flexible use in space and automotive manufacturing) is developing a modular robotic arm for multi-purpose and multi-mission use. A Kvaser Leaf Light HS v2 CB assures drive control and communication via CANopen, implemented using a Python CANopen API.

To minimize the need for inherently risky human interaction in servicing, maintenance, and assembly tasks in space applications, the application of robotic systems has obvious advantages. However, space robotic systems are traditionally created for specific purposes or applications, and often require a vast amount of design effort and cost, making them unfeasible for many missions.

A collaboration between the Institute of Space Systems (IRAS) at the Technical University of Braunschweig and the Institute of Structural Mechanics and Lightweight Design (SLA) at RWTH Aachen University, led to a project to develop a manipulator for use in space. The manipulator can physically adapt itself to the given location, modifying its length and degrees of freedom during operation.

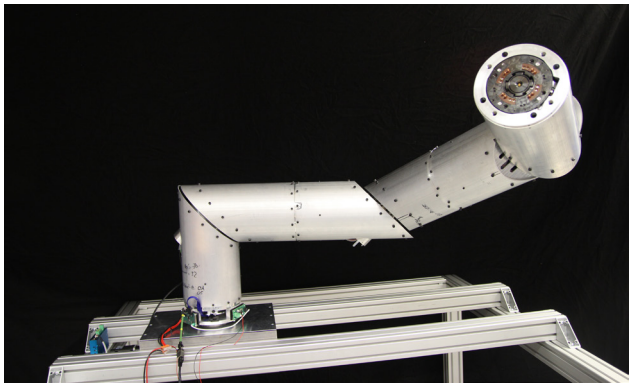


Figure 1: The manipulator can physically adapt itself to the given location, modifying its length and degrees of freedom during operation (Source: TU Braunschweig, RWTH Aachen University)

Two on-Earth demonstrators

The Homer team developed two on-Earth demonstrators; the “Little inspection and servicing arm” (Lisa) and the “Medium-sized arm for reconfiguration and grappling exercises” (Marge) to determine the operating loads, actuator and joint design, and optimize the structure. The team, comprised mostly of structural engineers, found themselves implementing CANopen to control and communicate with the drive system, without the benefit of a background in electronics.

Actronic Solutions provided valuable advice and support to the project, proposing the PCB-based (printed circuit board) CAN interfaces and supplying the servo drives. Kvaser's Leaf Light HS v2 CB (circuit boards) were used in each module to control servo drives from Copley Controls. With ▷

Brief facts

Project participants

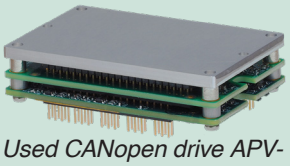
Institute of Structural Mechanics and Lightweight Design (SLA), RWTH Aachen University, Germany

The Institute of Space Systems (IRAS) of the Technical University of Braunschweig, Germany

Chair of Space Technology, Technical University of Berlin, Germany

Supporting companies

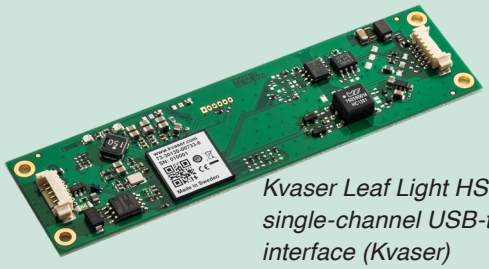
- Actronic Solutions
- Copley Controls
- Kvaser



Used CANopen drive APV-090-30 (Copley Controls)

Used CAN interface

The Kvaser Leaf Light HS v2 CB single-channel, high-speed, USB-to-CAN interfaces provided a reliable, low-cost connection to a PC.



Kvaser Leaf Light HS v2 CB single-channel USB-to-CAN interface (Kvaser)

More information

https://iopscience.iop.org/article/10.1088/1757-899X/1226/1/012096/pdf

‘Fully Modular Robotic Arm Architecture Utilizing Novel Multifunctional Space Interface’ by C. Zeis[1], C. A. de Alba-Padilla[2], K.-U. Schroeder[1], B. Grzesik[3], E. Stoll[3]. It was published in 11TH-EASN IOP Conference Series: Materials Science and Engineering 1226 (2022) 012096, IOP Publishing doi:10.1088/1757-899X/1226/1/012096

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up to seven axes to control, this was a simple implementation requiring one CAN connection per module. High reliability was essential, hence the choice of the CAN network and CANopen as higher-layer protocol.

"We found ourselves learning all about PDOs and SDOs from scratch. However, we achieved a system that performed in the way we expected it to and at the price point required, which was why we opted for an open-source CANopen API built in Python," noted Christopher Zeis, scientific assistant for the Institute of Structural Mechanics and Lightweight Design at RWTH Aachen.

Key project elements

A key element of the project was to integrate the multifunctional iSSI interface, designed by the Iboss (intelligent building blocks for on-orbit satellite servicing and assembly) project. The iSSI combines four sub-assemblies for power, data, heat, and mechanical load transfer. It uses a short-range optical communication to transmit data between modular Iboss building blocks (Iblocks). Each iSSI sub-assembly is controlled and monitored by the Interface Control Unit, which integrates an optical CAN interface as a backup network for low-data-rate tasks.

Next project steps

The next step for the Homer team is to build a space-certified demonstrator. Funding is pending, but potential applications for the modular robotic manipulator on Earth - as in space - are plentiful. Taking the idea of minimizing the need for inherently risky human interaction in servicing, maintenance and assembly tasks, the manipulator could be used in other harsh environments such as the ocean floor or in the confined, highly-radioactive space of a nuclear reactor. The modular, highly redundant design could also bring this technology within the reach of many more projects since it increases flexibility during production, reducing tooling times and enabling swift adaptability to create a variety of products.

Zeis concluded: "Our modular concept complements rather than replaces current robots. We firmly believe the approach has a place in factories of the future and we are open to research cooperation in this domain."

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