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Technical Specifications for Rapid Control Prototyper

This Rapid Control Prototyping (RCP) system will be used to quickly test and iterate control algorithms as well as test and measurement tasks for robotics and mechatronics research in an academic research laboratory. This system should comprise of both hardware and software components. The hardware should include real-time processors and FPGA (as detailed below) along with real-time I/O interfaces (also described below) and necessary communication interfaces to be able to connect this system to real world physical devices/robots. Detailed specifications are provided below:

Processor

- (1) Real-Time Processor:
 - (a) Dual Core or more, 2 GHz or more
 - (b) 32 KB L1 data cache per core or more, 32 KB L1 instruction cache per core, 512 KB (c) L2 cache per core, 2 MB L3 cache total
- (2) Host communication co-processor: 800 MHz or more for communication with host PC

Memory

- (a) 1 GB DRAM or more
- (b) 128 MB flash memory

Boot-time

Autonomous booting of applications from flash (depending on application size), ~5 s for a 5 MB application

Interfaces

- (1) Host interface - Integrated Gigabit Ethernet host interface
- (2) Ethernet realtime I/O interface - Integrated low-latency Gigabit Ethernet I/O interface.
- (3) USB interface - USB 2.0 interface for data logging ("flight recorder") and booting applications via USB mass storage device (max. 32 GB supported)
- (4) CAN interface - 2 CAN channels (partial networking supported)
- (5) Serial interface - 2 x UART (RS232/422/485) interface
- (6) LVDS interface - 1 x LVDS interface to connect with the Programmable Generic Interface PGI1.

Programmable FPGA

50950 Slices or more, 326080 Logic Cells or more, 407600 CLB Flip-Flops or more

Analog Input

(1) Resolution and type:

- (a) 8 14-bit channels, 10 Msps, differential; functionality: free running mode
- (b) 24 16-bit channels, 1 Msps, differential; functionality: single conversion and burst conversion mode with different trigger and interrupt options

(2) Input voltage range: -10 to 10 V

Analog Output

(1) Resolution and type: 16 16-bit channels, 1 Msps, settling time: 1 μ s

(2) Output voltage range: -10 to 10 V

(3) Output current: ± 8 mA

Digital I/O

(1) 48 bidirectional channels, 2.5/3.3/5 V (single-ended); functionality: bit I/O, PWM generation and measurement (10 ns resolution), pulse generation and measurement (10 ns resolution), 4 x SPI Master

(2) 12 bidirectional channels (RS422/485 type) to connect sensors with differential interfaces

Electric Motor Control I/O Functionality

(1) Separate interfaces: 2 x Resolver interface

(2) Functionality on digital I/O channels

- (a) 6 x Encoder sensor input
- (b) 2 x Hall sensor input
- (c) 2 x EnDat interface
- (d) 2 x SSI interface
- (e) Synchronous multi-channel PWM
- (f) Block commutational PWM

Sensor Supply

(1) 1 x 12 V, max. 3 W/250 mA (fixed)

(2) 2. 1 x 2 ... 20 V, max. 1 W/200 mA (variable)

Cooling

Active cooling (temperature-controlled fan)

Physical Connections

(1) 2 x Sub-D 50 I/O connectors

(2) 48 x BNC I/O connectors

(3) 4 x Sub-D 9 I/O connectors

(4) 3 x RJ45 for Ethernet (host and I/O)

- (5) USB Type A (for data logging)
- (6) 2 x 2 banana connectors for sensor supply
- (7) Power supply

Physical Characteristics

- (1) Enclosure size: Max size of 310 x 250 x 115 mm
- (2) Temperature - 0 to 50 °C (ambient temperature)
- (3) Power supply - 100 to 240 V AC, 50 to 60 Hz

Software

- (1) The software component should be able to interface with codes in MATLAB/Simulink. We already have MATLAB/Simulink Licenses the supplier should provide software to interface MATLAB/Simulink with RCP such that these codes can directly be imported into the RCP for testing with actual physical setups.
- (2) The software component that interfaces RCP with MATLAB/Simulink should provide specific modules in MATLAB/Simulink for Electric Motor Control. It should have dedicated I/O functions for relevant sensors such as Resolvers, Encoders & Hall Sensors and should also be capable of configuring PWM channels.
- (3) The software component that interfaces RCP with MATLAB/Simulink should provide specific modules in MATLAB/Simulink to be able to program and configure the FPGA. It should be able to implement interrupt-driven tasks in the processor model triggered from the FPGA model and should allow connecting the FPGA model with the processor model running on the RCP.
- (4) The software component that interfaces RCP with MATLAB/Simulink should provide specific modules in MATLAB/Simulink to connect the RCP with Ethernet devices and networks. This should allow communication of data between segments of control algorithms running on different devices on an Ethernet network.
- (5) The software should also provide real-time test software module with functionality to connect the RCP to a host PC where real-time data feeds from the physical robot/device is being displayed and also real-time parameters (such as controller gains) are being manipulated. There should be GUI provided where a user can make this visual display and parameter control knobs etc. on the host PC screen. There should also be a functionality of logging real-time data to the host PC.
- (6) Software licensing should be permanent in nature.