Midterm Presentation - Safety Car
HW/SW-Co-design with (LEGO)Cars

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Content

Hardware Overview

Key-Components:

- *wooden chassis*, aprox. 40 cm x 35 cm
- *12.6 V battery* with continuous 90 A ($\Rightarrow$ 1134 W!)
  Central power-management
  (generating 5 V for FPGAs and 9 V for Ethernet-Switch)
- *4 CMWUnits* (ControlMotorWheel-Unit) see next slide...
- *Central FPGA* which controls every CMWUnit and sensor
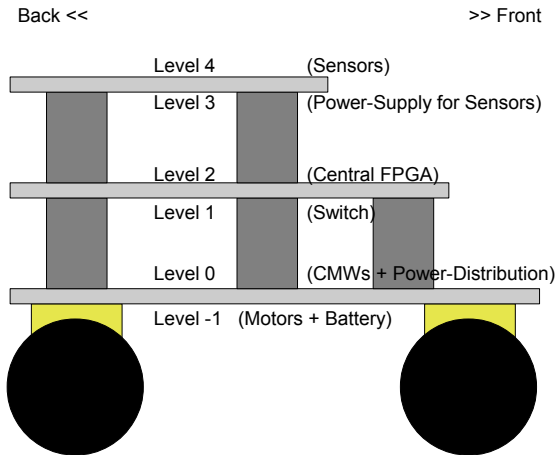- different *Sensors*

Car Design - Overview

Back <<   >> Front

Level 4   (Sensors)
Level 3   (Power-Supply for Sensors)
Level 2   (Central FPGA)
Level 1   (Switch)
Level 0   (CMWs + Power-Distribution)
Level -1   (Motors + Battery)

Figure : The car is divided into five levels. Each level has a different motto.

Level -1

The lowest level contains the four motors and the battery.
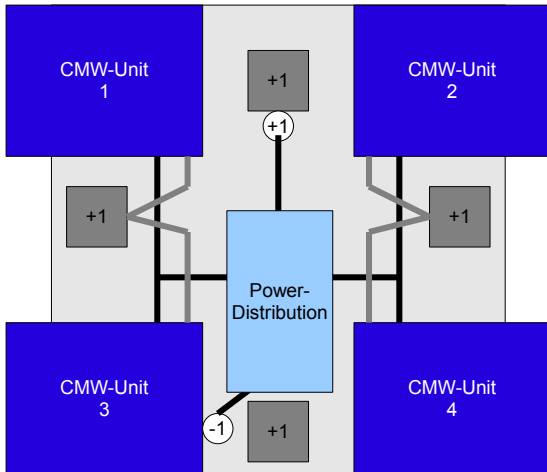
Level 0

Figure : Level 0 contains the CMW-Units and the Voltage-Distribution

CMWUnit - Control-Motor-Wheel-Unit

Each Control-Motor-Wheel(CMW)-Unit consists of:

- One *Ethernet-UART* connected to the central FPGA
- One *DE0Nano-Boards* (FPGA)
- One *H-Bridge* (dual-channel but we only use one channel)
- One *Pololu Motor* (max. power: 60 W @ 12 V, 5 A).
  Problem: Many components can not take over 2 A!
- One *Soft-Wheel* (diameter: aprox. 12 cm)
  Problem: Each Soft-Wheel can take max. 3 kg
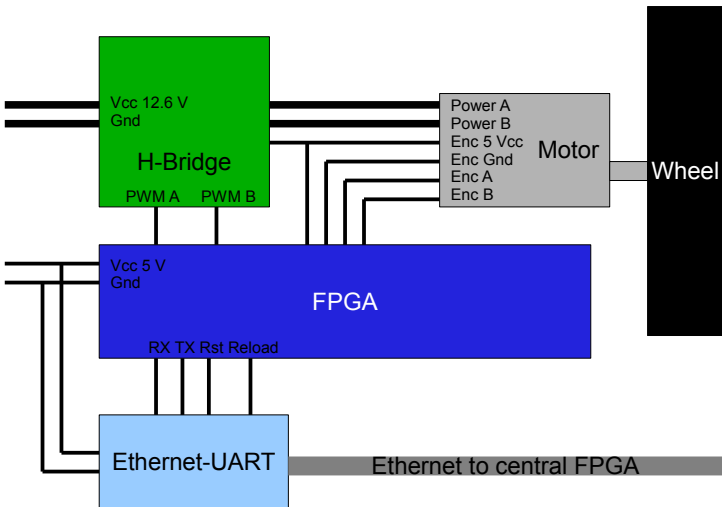
CMWUnit - Control-Motor-Wheel-Unit

Figure : Interconnections in the Control-Motor-Wheel-Unit
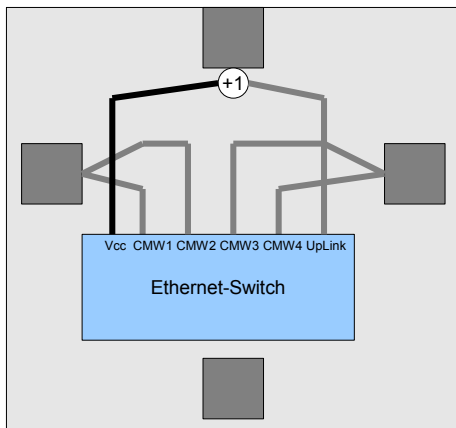
Level 1

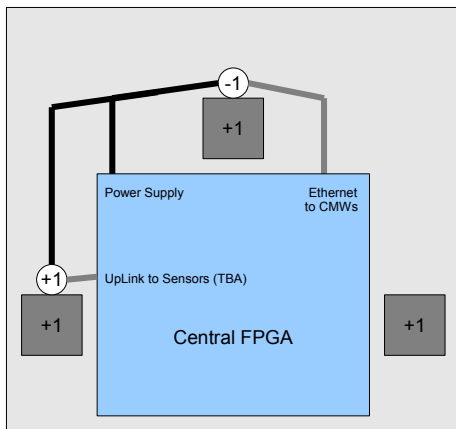

Figure : Level 1 contains the Ethernet-Switch

Level 2

Figure : Level 2 contains the (big) Central-FPGA
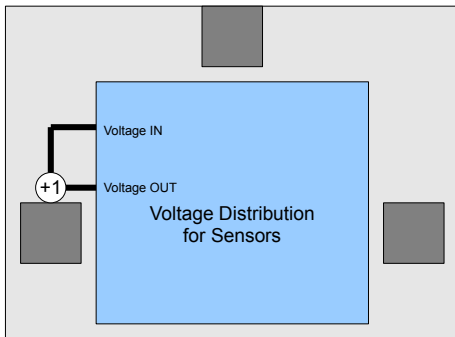
Level 3

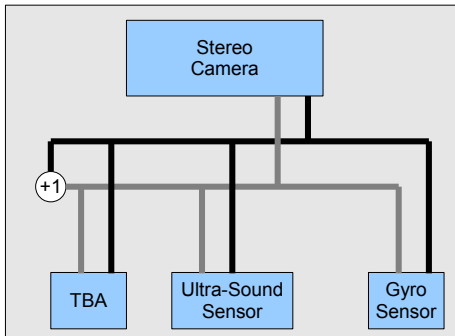Figure : Level 3 contains the Power-Supply for the Sensors

Level 4

Figure : Level 4 contains the Sensors

Our Aims

We want to reach these architectural aims:

1. hierarchical and distributed System
   (e.g. separated Motor-Control)

2. Plug-N-Play functionality
   (interactive protocols, drivers, ...)

3. self-maintaining car
   (calibration mode, no hardcoded constants, ...)

4. simple programming of the master-controller (FPGA)
   (e.g. Drag-N-Drop, ...)