POLITECNICO DI TORINO

Electronics for Embedded Systems

Project of the course

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Data: November 13, 2019

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1 Introduction

I'm very glad to present by this report, my own project for Electronics for Embedded Systems course. The main idea consists in realizing a camera able to capture photos to be transferred to an host computer for further processing. Before describing in details the environmental structure, I guess it's fundamental to highlight that all the topics of the course have been covered in the following manner:

- **Memory**: memory controller as FSM
- **Programmable logic device**: acts as remote to send the user command
- **Interconnection protocol**: I2C, SCCB and UART
- **Peripheral management**: programming of camera peripheral
- **AD and DA converters**: usage of AD converter to sample the luminance of the environment
- **Power management**: Step-down converter to drive a LED

Each of them owns a proper section below.
Let's have a look on the general architecture, listing the main parts of the system. The camera is connected to an ST microcontroller: a STM32F446ZET. The choice on this MCU has due to the fact that it integrates a very useful and widespread engaged peripheral in the video-capturing field: the Digital CaMera Interface (**DCMI**). All images are sent to the host computer by UART protocol, exploiting another embedded peripheral of the microcontroller. Computer reads UART's data plugging a USB-UART adapter. Then a small Python script converts those data into a BMP image.
The command is generated by the user pushing a specific button. An 8 buttons keyboard is tied up to the FPGA: an Altera Cyclone IV on DE0-Nano board. The implemented VHDL is composed of the keyboard driver and a fully structural UART peripheral. When a button has clicked, an encoded 8-bit data is sent to the microcontroller, which, by an interrupt, recognizes that the user pushed something.
A breadboard has been used to build circuits for AD and Bulk converters. For sure, the following image is more clarifying for the reader.

I used to program the microcontroller STM32 CubeIDE, a software Eclipse based. To program the FPGA I exploited both Quartus II when uploading the *sof* file and Xilinx ISE Design Suite when simulating (just for my high familiarity with that). Moreover, as classical laboratory instruments I relied on an oscilloscope provided by GW Instek and a multimeter for resistor measurements.

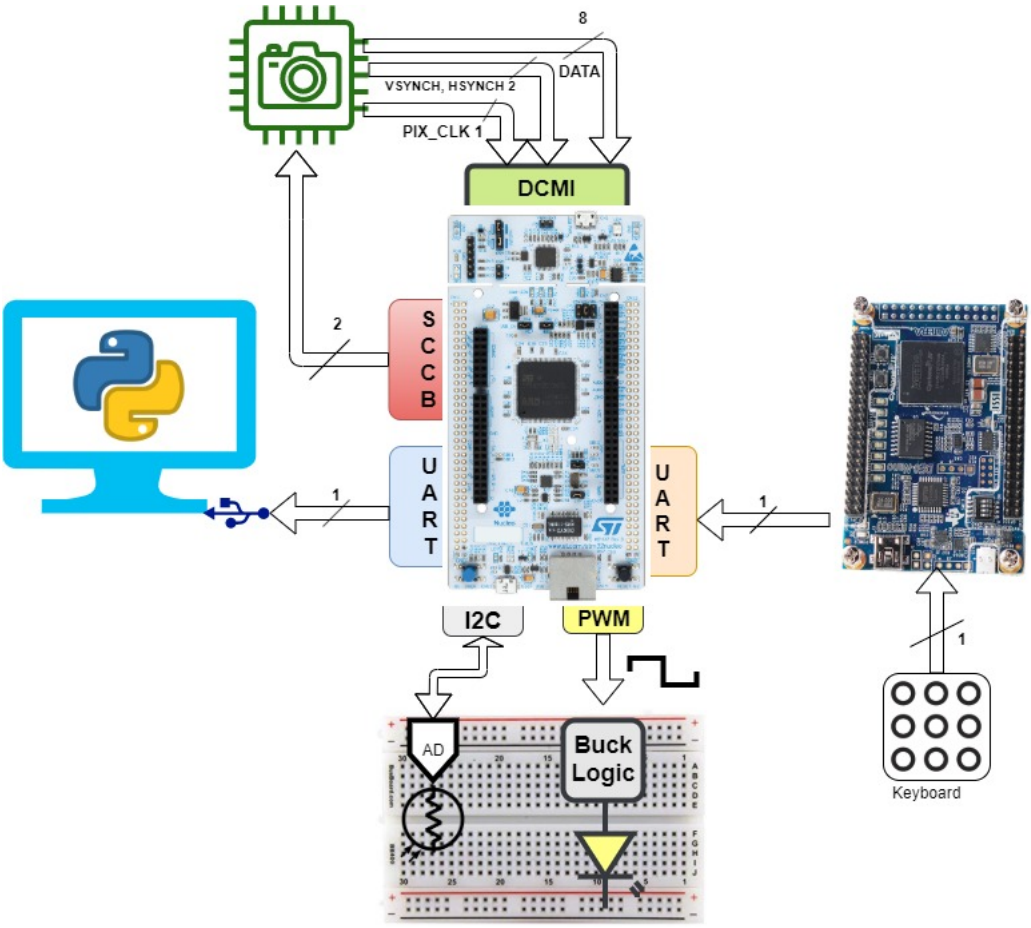

Figure 1: General block schema

What actually is

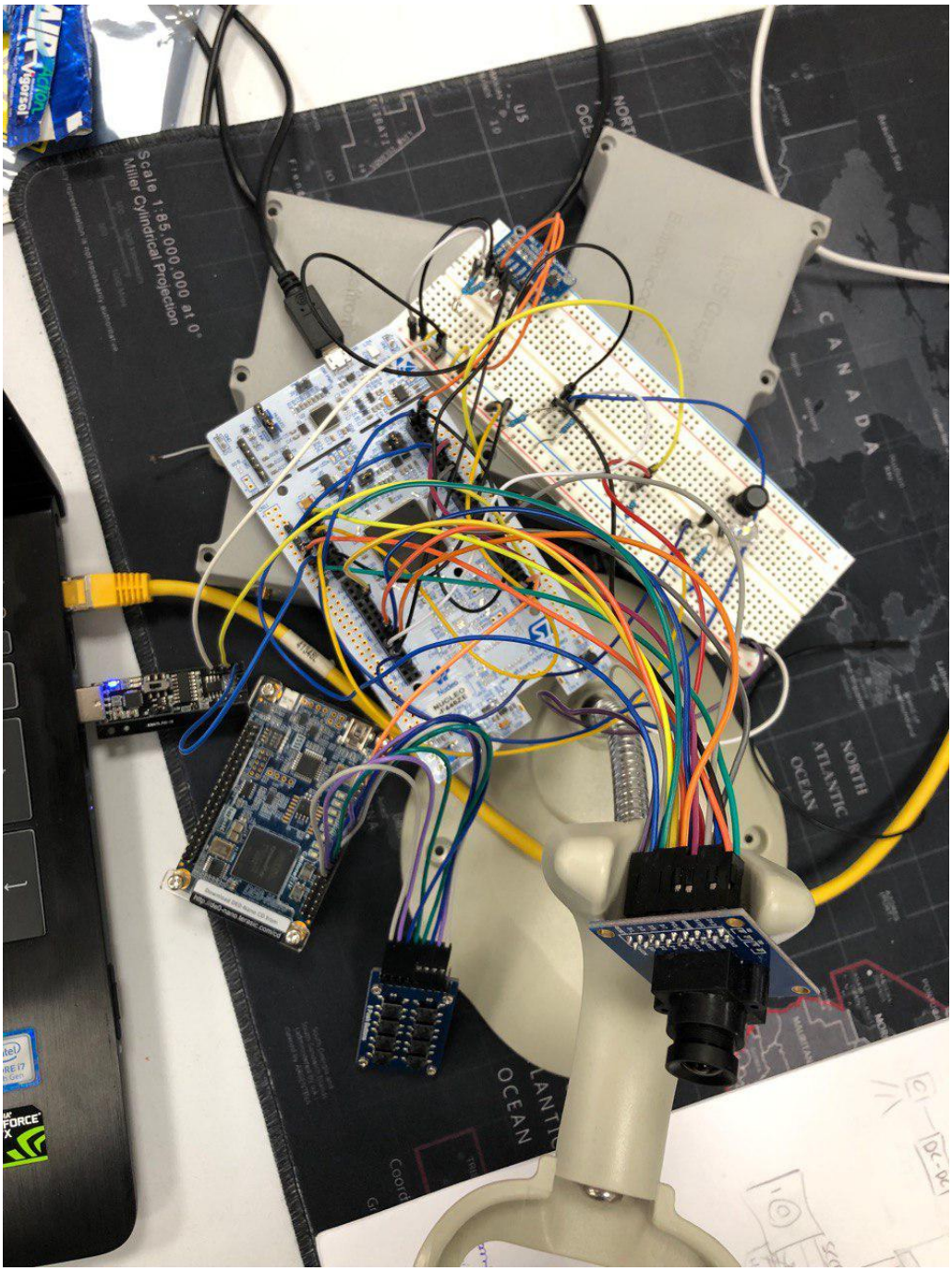

Figure 2: Real system