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Master Thesis

High speed multichannel camera with 10 GbE

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Abstract

$_{t}ext$

Chapter 1

Introduction

Camera design technology exists since the discovery of bla bla bla The following thesis is divided into 6 chapters. The first chapter describes thescientific camera design, the theory and current state of technology and alsothe reasons for doing this work as well as the basic requirements. Secondchapter presents the concept phase of the project, where the informationregarding possible ways of achieving the requirements is presented. After theconcept chapter, the realisation is described in chapter 4.

1.1. Camera design theory

This section introduces the topic of scientific camera design. Reasons to do this work are presented as well as the today's state of knowledge regarding camera design.

1.1.1. Camera parameters

Frames per second

$fps = \frac{n}{T}$

1.1.2. Mechanics

Chasis

Shutter

Optics

Lens parameters

Mounts

1.1.3. Electronics

Main control units

FPGA

SoC

Application processor

ASICs

Microcontroller

Video data storage

SSD

HDD

SD Card

Flash

1.1.4. Firmware

Firmware in a camera is responsible for numerous functions of the device. Most cameras incorporate application processors, SoC or more advanced microcontrollers which run program usually written in C. Those who doesn't are usually specialised cameras which use ASIC to acquire an image and control the functions of the device. Frequently, firmware is highly complicated and incorporate digital system (HDL), low level drivers, high level operating systems like embedded Linux, Android or Windows CE.

Embedded Linux camera specific firmware

Linux operating system provides many tools and programs which can be used in a camera.

Embedded camera systems which runs Linux operating system can benefit from a number of libraries available for this Operating System.

The following list provides some of the most popular programs.

- video4linux
- gstreamer
- ohc/evcusb
- Qt
- Wayland
- OpenCV

1.1.5. Sensors

CMOS

CCD

Other

1.1.6. Interface

Wire based interfaces

USB

Camera Link

ThunderBolt

FireWire

Ethernet

Wireless

Bluetooth

WiFi

Optical

1.2. Scientific camera design theory

1.2.1. Features

Extremely low noise

Binning

Throughput

Ethernet

Existing devices on the market

Elphel camera

Creotech K20 Camera

IoT camera

Other

1.2.2. Summary

1.3. Reasons to do this project

Universal open, camera design architecture One cannot deny the fact that, novelty is the in today's hightech electronics market the most important aspect of the product is time-to-market. Sometimes even a worse product can win on the market just due to the fact that it was released eariler. In specialised markets where COTS (Custom - Off - The - Shelf) components are being used by customers, the possibility to quickly adjust the parameters of a specific system given suited to the customers need is a key to success. Another

Scientific applications for camera systems are, undoubtedly broad.

1.4. Requirements

The following list provides basic parameters for the designed camera framework. high processing performance - for support of high resolutions ease of adding a support for a different sensor Secure and versatile OS RTOS capability Future proof high speed communication - to send high amounts of data live multichannel operation - astronomical as well as medical applications require it As described in previous sections, mechanics, casing, envirionment related design choices are different for each camera project. This is why this work doesn't consist of design of optics and other mechanical aspects of camera design. This project goal is to address the intersection of all camera problems provide a framework that will allow for faster development.

1.5. Summary

Chapter 2

Genesis, goals and assumptions

Chapter 3

Concept of realisation

Chapter 4

Realisation

4.1. Firmware

4.2. Digital system design

Chapter 5

Tests

Chapter 6

Summary

Appendix A

CD-ROM

- test