ENG-603 **Solid state image sensing**

Seitz Peter

Cursus	Sem.	Type
Photonics		Obl.

Language of teaching	English
Credits	2
Session	
Exam	Oral
Workload	60h
Hours	**30**
Courses	24
Exercises	6
Number of positions	

Frequency

Every 3 years

Remark

Next time: Spring 2018 - To be confirmed

Summary

This course provides a complete overview over all types of solid state image sensors employed today, their operation, their properties and their limitations. Quantum detectors as well as thermal detectors are discussed, provided that they can be fabricated with semiconductor materials...

Content

1. Optoelectronic properties of semiconductors. Interaction of light with silicon and selected compound semiconductors. Photodiodes. Modulation transfer function and responsivity.
2. The charge-coupled device (CCD) principle. Surface and buried channel CCD. CCD image sensors. CCD signal processing (transversal filtering, convolution image sensor, lock-in pixels for optical time-of-flight range imagesensing)
3. Photosensor output stages (amplifiers) and their noise properties. Noise reduction techniques. From CCD to CMOS image sensing with Active Pixel Sensors (APS). Photosensors with ultimate performance: Skipper CCD, double-gate FET CCD, CMD, avalanche multiplication in pixels and in imager output stages (Impactron), techniques for high-dynamic range imaging (multi-exposure, logarithmic and LinLog compression, etc.)
4. Human visual perception and video standards for black-and-white and color cameras. Unconventional photosensing principles: charge injection device (CID), bucket brigade device (BBD), position sensitive detectors (PSD), phototransistors, etc.
5. Photosensing with organic semiconductors: small molecules and polymers. Photocharge carrier transport mechanisms. Charge injection. Light emission and detection. Organic microelectronics and optoelectronics
6. Thermal radiation detectors for the infrared spectral range: Microbolometers, micro-thermocouples, CMOS-compatible IR detectors using free-carrier-absorption (FCA) and inter-subband interaction effects in silicon.
7. State-of-the-art photosensors and future developments in "single-chip cameras" and "smart pixels". Case studies of present-day optical measurement problems and their possible solution with advanced Photosensors.

Keywords

photosensing, image sensing, CMOS, CCD, semiconductors

Learning Prerequisites

Required courses

1. Physique générale I – IV
2. Electronique I + II

Recommended courses

Méthodes de détection optique

Important concepts to start the course

1. Fundamentals of semiconductor physics.
2. Fundamentals of optics.
3. Basic elements of electronics.

Teaching methods

Every lesson includes the preliminary discussion of a few advanced problems that are not be solved directly in class; these problems are therefore given as take-home projects to student groups, who will present the information collected and their solution approach in five-minute briefs in one of the later lessons.

Expected student activities

To 80% of the given problems a correct written solution must be handed in Diligent and dutiful participation in the personal Q&A interviews during the lessons.
Active contributions to the in-class brainstorming sessions.

Assessment methods

Detailed analysis of the written solutions to the given problems.
Personal Q&A interviews of individual students during the lessons.
Individual contributions of students during in-class brainstorming sessions.

Resources

Bibliography

Distributed during the course in a PDF filed.

Notes/Handbook

PDF files with lecture notes will be distributed during the course.

Websites

- http://cmos-image-sensor.blogspot.ch/2010/06/list-of-image-sensor-books.html
- http://link.springer.com/book/10.1007/978-3-642-18443-7/page/1
- http://www.embedded-vision.com/news/2011/11/08/image-sensor-online-tutorial-make-you-subject-master-plus-way-out-kodaks-fisca