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Lappeenranta University of Technology
LUT Machine Vision and Pattern Recognition 2016-01-22

BM40A1200 Digital Imaging and Image Preprocessing

Lasse Lensu, Tuure Tuuva and Erik Vartiainen

Exam 2016-01-28

In addition the writing instruments, allowed items in the exam: a calculator.

Other instructions: i) justify your answers well and ii) if there is any additional material provided with this exam paper, it must be returned with your answers.

1. Understanding of concepts (10 p): Explain briefly the following terms related to digital imaging and image processing. In the case of more than one term (. . . *vs.* . . .), explain also the differences of the mentioned terms. The maximum length of the answer to the whole task is **1 page**.
   (a) Binning
   (b) Chromatic aberration
   (c) Intrinsic camera parameters *vs.* extrinsic camera parameters
   (d) Linear filter *vs.* non-linear filter
   (e) Wavefront
2. Imaging technology (10 p): Describe the two main image sensor types utilized in digital cameras today. Compare the operating principles in short and mention benefits of each sensor type.
3. Laser output (10 p): The pulse energy of a laser is 1 nJ, the pulse width 80 fs and the repetition rate of pulses 60 MHz.
   (a) Estimate the average radiant flux and the peak flux (pulse height in watts) of the laser output.
   (b) If the beam is focused by a lens to the diameter of 500 nm, what is the irradiance at the focus? The pulse shape can be approximated as rectangular and the beam cross-section as circular.
4. Stimulated emission depletion (STED) microscopy (10 p): Explain in detail the operating principle of and components needed for STED microscopy.
5. Image noise and calibration (10 p): Image pixel values represent the light intensity from the scene projected onto the light-sensitive area of the digital camera sensor.
   (a) List the different types and characteristics of noise altering the image pixel values.
   (b) Describe in detail the procedure and the needed images for calibrating the pixel values to properly represent the light intensities.

PO BOX 20, FI-53851 LAPPEENRANTA, FINLAND
E-mail: lasse.lensu@lut.fi