Computer Vision (CV) (English) – JMU Wuerzburg, Master, Spring 2021

There are **4 home assignments** roughly corresponding to the teaching sessions. They are counting for a 10% bonus in the final grade for this course and are meant for familiarizing the students with the written exam which will contain similar tasks.
Each home assignment (HA) has 8 topics that are weighted equally. The solutions to each HA should be sent as a single *pdf* by email at radu.timofte@uni-wuerzburg.de no later than May 26 for HA1, June 10 for HA2, July 1 for HA3, and July 15 for HA4, respectively. Each student shall include with her/his email full name and the details of the study program. The Subject of the email should be of the form:
**"CV 2021 HA[#home_assignment] [master_program] [lastname] [firstname]"**
where [#home_assignment] should be replaced with the number of the home assignment, the [master_program] with the corresponding short abbreviated program (like XtAI, LuRI) and [lastname] and [firstname] are the student's last name and first name, respectively.
The grades on the home assignments will be provided together with the final course grade.
Plagiarism and misconduct are not tolerated!
The grading of Computer Vision (taught in English) is as follows:

- **The final CV (Eng) grade (maximum 100%)** is composed from 100% written exam.
- Up to **10% extra bonus** will be awarded for those attending the lectures.
- Up to **10% extra bonus** will be awarded for those attending the exercise sessions.
- Up to **10% extra bonus** will be awarded for those sending their solutions to the HAs.
- For **exam** the students are required to prepare the contents covered during the lectures, exercise sessions, home assignments and found on the provided slides and lab materials. Examples of potential exam topics are found in the HAs.

# Home assignment I

(due May 26th, 2021)

1. What is Computer Vision? Why is it important? How Computer Vision relates with Computer Graphics? Give the most important 3 applications of computer vision in your opinion and argument your selection and ranking.

2. What is light refraction? Can the angle of reflection be different than the angle of incidence? When and why? Justify your answers.

3. Describe the rainbow and the sunset. Which phenomena, types of light interaction with matter, are involved in the creation of the rainbow and sunset effects? Be as thorough as possible in your response and justify.

4. What is depth of field? If the focal length is assumed fixed, can aperture be adjusted to help in handling objects at far and near distance, respectively? Justify your answers.

5. The task is fabric classification into a couple of categories. The fabric image is captured with a camera facing a planar fabric. The fabric image shows a patch from the fabric and nothing else. It is known that the fabrics can come in all the colors and shapes, regardless their category. What color space and which channel(s) should be used? What features and descriptors would be the best for this task? Are these scale invariant? Justify your answers.

6. A gray image with pixel grey-level values is represented on 8 bits [0..255]. All the pixel values belong in fact to the range [0..58]. What is the minimum number of bits that can be used for representing the values in this image without loss of information/details? Given a budget of 3 bits devise a quantization procedure such that to minimize the quantization error. In what situation the uniform quantization is the best solution? Justify your answers.

7. Given a sequence 1, 3, 1, 5, 100, 2, 4, 2, 1 what are the results obtained by applying a mean filter, a median filter, a maximum filter, and a minimum filter, respectively. For each filter the support

window is of length 3. If it is know that this sequence of values comes from a distribution with mean 2 and standard deviation 2, what is the “outlier” from the sequence? If this is a normal distribution and we can sample an infinite amount of values, what is the probability to have values above 20? Justify your answers.

8. For what types of noise median filtering is clearly preferable over Gaussian filtering? Justify your answer.

a) Exponential noise model
b) Salt and pepper noise
c) Rayleigh noise
d) Uniform noise, i.e. distributed by uniform distribution
e) Gaussian noise, i.e. noise distributed by independent normal distribution