#### 16-385 Computer Vision, Fall 2020

# Take-home Quiz 6

#### Due Date: Tuesday October 27, 2020 23:59

### Question 1 (5 points)

We observe a Lambertian cube with uniform albedo under unit-strength, directional illumination from an unknown direction  $\hat{\mathbf{s}}$ . The cube is viewed in such a way that three of its faces are visible, with known normal vectors  $\hat{\mathbf{n}}_1$ ,  $\hat{\mathbf{n}}_2$ , and  $\hat{\mathbf{n}}_3$ . Show that the cube's albedo  $\rho$  and the illumination direction  $\hat{\mathbf{s}}$  can be recovered from the observed radiance  $(I_1, I_2, \text{ and}$  $I_3)$  emitted from the three faces. Write expressions for  $\rho$  and  $\hat{\mathbf{s}}$  in terms of  $\{\hat{\mathbf{n}}_i\}$  and  $\{I_i\}$ .

## Question 2 (5 points)

Consider a surface patch with BRDF

$$f_r(\hat{\mathbf{s}}, \hat{\mathbf{v}}, \hat{\mathbf{n}}) = \frac{1}{\sqrt{\hat{\mathbf{n}}^\top \hat{\mathbf{s}}} \sqrt{\hat{\mathbf{n}}^\top \hat{\mathbf{v}}}},$$

where  $\hat{\mathbf{n}}$ ,  $\hat{\mathbf{v}}$ , and  $\hat{\mathbf{s}}$  are the surface normal, view, and source directions, respectively. Suppose we view such a patch from a known direction  $\hat{\mathbf{v}}$ , and we capture two radiance measurements  $E_1$  and  $E_2$  under unit-strength distant lighting from known directions  $\hat{\mathbf{s}}_1$  and  $\hat{\mathbf{s}}_2$ .

- 1. Write expressions for the measurements  $E_1$  and  $E_2$  in terms of the normal, view, and source directions.
- 2. Show that we can recover the surface normal from these two measurements.

*Hint:* Use the reflectance equation to compute the outgoing radiance measurements  $E_1$  and  $E_2$ .

## Instructions

- 1. Integrity and collaboration: Students are encouraged to work in groups but each student must submit their own work. If you work as a group, include the names of your collaborators in your write up. Plagiarism is strongly prohibited and may lead to failure of this course.
- 2. Questions: If you have any questions, please look at Piazza first. Other students may have encountered the same problem, and it may be solved already. If not, post your question on the discussion board. Teaching staff will respond as soon as possible.

- 3. Write-up: Your write-up should be typeset in LATEX and should consist of your answers to the theory questions. Please note that we **do not** accept handwritten scans for your write-up in quizzes.
- 4. Submission: Your submission for this take-home quiz should be a PDF file, <andrew-id.pdf>, with your write-up. Please do not submit ZIP files.