8 Further Graphics (aco41)

(*a*) We want to render a single triangle with vertex locations $\mathbf{v}_1$, $\mathbf{v}_2$, $\mathbf{v}_3$, and the normal $\mathbf{n}$. Assume the outgoing light in a fixed direction has radiance L_1 at $\mathbf{v}_1$ and L_2 at $\mathbf{v}_2$. The BRDF is the same everywhere on the triangle.

(*i*) What is the outgoing light radiance in the same fixed direction at some point on the triangle if we assume only a directional light source that emits light in a single direction? Explain the steps with equations. [4 marks]

(*ii*) What is L_2 in terms of L_1 if we assume diffuse reflection and only a point light source at the point $\mathbf{v}_1 + t\mathbf{n}$ that emits light of equal radiance in all directions? Explain the steps with equations. [5 marks]

(*b*) A mesh is attached to two bones via rigging with weight functions $w_1(\mathbf{x})$ and $w_2(\mathbf{x})$ and linear blend skinning.

(*i*) For a vertex with position $\mathbf{x} \in \mathbb{R}^3$ on the mesh, give the expression of the new position of this vertex after applying the transformations $\mathbf{T}_1$ and $\mathbf{T}_2$ to the two bones, where the $\mathbf{T}$s are 4×4 transformation matrices. [2 marks]

(*ii*) Assume rotations for both bones are around the same axis. Does linear blend skinning provide a valid rigid transformation in this case? [2 marks]

(*iii*) Assume both bones are rotated using the same matrix. Does linear blend skinning provide a valid rigid transformation in this case? [2 marks]

(*iv*) You now want to further translate the vertex by $\mathbf{t} \in \mathbb{R}^3$. Give the expression of the transformation matrix $\mathbf{T}$ to be added to $\mathbf{T}_1$ to achieve this. Assume that $\mathbf{T}$ represents a valid rigid transformation with no rotation. Explain the steps with equations. [5 marks]