Assignment 4: CS 763, Computer Vision

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Due 29th March before 11:55 pm

Question 2

Let the water surface have the equation $z = h(x, y)$. Thus, the normal to the surface is given by $\mathbf{n}(x, y) = \left(-\frac{\partial h}{\partial x}, -\frac{\partial h}{\partial y}, 1\right)$.

As $\mathbf{s}$, $\mathbf{r}$ and $\mathbf{n}$ lie in the same plane, $(\mathbf{s} \times \mathbf{r}) \cdot \mathbf{n} = 0$. Now, $\mathbf{s} \times \mathbf{r} = (\mathbf{r}_y, -\mathbf{r}_x)$ and $\mathbf{n}(x, y) = \left(-\frac{\partial h}{\partial x}, -\frac{\partial h}{\partial y}, 1\right)$. Thus, we get $\frac{\mathbf{r}_y}{\mathbf{r}_x} = \left(\frac{\partial h}{\partial y}\right) / \left(\frac{\partial h}{\partial x}\right)$. Hence, $(\mathbf{r}_x, \mathbf{r}_y)$ is parallel to $(\frac{\partial h}{\partial x}, \frac{\partial h}{\partial y})$.