Intrinsic image model was introduced by **intrinsic-image**. It represents that an image I can be decomposed as the element-wise product between the reflectance R of the object and the shading S produced by the interaction between light and objects.

$$I = R \odot S$$

The equation can be further decomposed based on different surface models. If assume the object surfaces are Lambertian surfaces, i.e. the diffuse surfaces, the equation can be decomposed further as follows

$$I = \rho \odot (L_0 \mathbf{L} \cdot \mathbf{N})$$

where ρ is the reflectance of diffuse surface, also know as albedo, L_0 is the radiance of incoming light, i.e. irradiance, $\mathbf{L}$ is the direction of incoming light as unit vector map and $\mathbf{N}$ is the surface normal also as unit vector map.

The decomposition gives a constraint of the normal map with given other information, which can be considered further in the deep learning model. The image I is given in the RGB-D image, the light map $\mathbf{L}$ can be calculated based on the light source and the vertex map. Since the brightness L_0 of the image is not take into account when we calculate the surface normal, it is save to remove it in the equation. Using the predicted surface normal map $\hat{\boldsymbol{N}}$, then the calculated albedo $\hat{\rho}$ is as follows

$$\hat{\rho} = \frac{I}{\mathbf{L} \cdot \hat{\mathbf{N}}}$$

The accuracy of $\hat{\rho}$ is related to the accuracy of $\hat{\boldsymbol{N}}$.

As shown in Figure 1, According to the Lambertian reflectance model, the

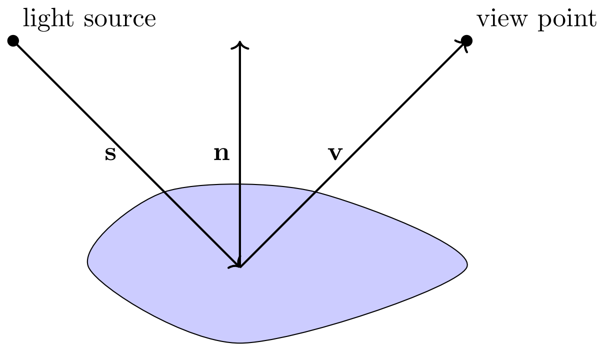

Figure 1: Lambertian Surface

relationship between image and the surface model is

$$I = \rho(\mathbf{N} \cdot \mathbf{L})$$

where I is the total power , ρ is the albedo, N is the normal map and L is the incoming light direction.