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Looking Into the Water by Unsupervised Learning of the Surface Shape

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We address the problem of looking into the water from the air, where we seek to remove image distortions caused by refractions at the water surface. Our approach is based on modeling the different water surface structures at various points in time, assuming the underlying image is constant. To this end, we propose a model that consists of two neural-field networks. The first network predicts the height of the water surface at each spatial position and time, and the second network predicts the image color at each position. Using both networks, we reconstruct the observed sequence of images and can therefore use unsupervised training. We show that using implicit neural representations with periodic activation functions (SIREN) leads to effective modeling of the surface height spatio-temporal signal and its derivative, as required for image reconstruction. Using both simulated and real data we show that our method outperforms the latest unsupervised image restoration approach. In addition, it provides an estimate of the water surface.