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Artificial intelligence as a tool to study the 3D skeletal architec-ture in newly settled coral recruits: insights into the effects of Ocean Acidification on coral biomineralization

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Understanding the formation of the coral skeleton has been a common subject uniting various marine and materials study fields. Two main regions dominate coral skeleton growth: Rapid Accretion Deposits (RADs) and Thickening Depos-its (TDs). These have been extensively characterized at the 2D level, but their 3D characteristics are still poorly described. Here, we present an innovative ap-proach to combine synchrotron phase contrast-enhanced microCT (PCE-CT) with artificial intelligence (AI) to explore the 3D architecture of RADs and TDs within the coral skeleton. As a reference study system, we used recruits of the stony coral Stylophora pistillata from the Red Sea, grown under both natural and simulated ocean acidification conditions. We thus studied the recruit's skeleton under both regular and morphologically-altered acidic conditions. By imaging the corals with PCE-CT, we revealed the interwoven morphologies of RADs and TDs. Deep-learning neural networks were invoked to explore AI segmentation of these regions, to overcome limitations of common segmentation techniques. This analysis yielded highly-detailed 3D information about the RAD's and TD's architecture. Our results demonstrate how AI can be used as a powerful tool to obtain 3D data essential for studying coral biomineralization and for exploring the effects of environmental change on coral growth.