Measurement of a One-dimensional Axisymmetric Flow Profile with Eddy Current Flow Meters and Deep Neural Networks

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Eddy Current Flow Meters (ECFMs) measure flow in conductive fluids. ECFMs are well suited for applications in nuclear reactors. They provide external measurements of flow in fluids that are often difficult to measure. Traditionally, ECFMs operate at a single frequency limiting measurements to average fluid velocities, blockages, and/or voids. We measured fluid velocity profiles by making several ECFM sensitivity measurements at a range of frequencies allowing us to probe the fluid velocity at various radial locations. The relationship between ECFM measurements and velocity profiles requires solving an inverse problem, for which traditional methods are ill-suited. However, using electromagnetic simulations to train a Deep Neural Network, we created a relationship between ECFM measurements and fluid velocity profiles. Using ECFM measurements, our model agrees well with computational fluid dynamic (CFD) simulations while remaining stable. This technique can potentially improve flow monitoring for safe and optimized operation of conductive fluid loops, and/or validating CFD models.