On a nonlinear PDE arising in magnetic resonance electrical impedance tomography (MREIT)

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We consider the fundamental questions, such as existence and uniqueness, of a mathematical model arising in MREIT system, which is electrical impedance tomography technique integrated with magnetic resonance imaging. The mathematical model for MREIT is the Neumann problem of a nonlinear ellptic partial differential equation $\nabla \cdot \left(\frac{a(x)}{|\nabla u(x)|} \nabla u(x) \right) = 0$. We show that this Neumann problem belongs to one of two cases: either infinitely many solutions or no solution exist. This explains rigorously the reason why we should utilize two distinct measurements. With two measurements, we prove a uniqueness result on the edge detection of a piecewise continuous conductivity distribution.