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We develop a novel rotationally invariant three-dimensional texture classification scheme using Gaussian Markov Random Fields on \mathbb{Z}^3 to model textures sampled on a discrete lattice. To obtain these samples we restrict the domain of definition of a continuous texture considered as a realization of a stationary Gaussian Random Field on \mathbb{R}^3 to \mathbb{Z}^3 . Using the mathematical framework of the Isotropic Multiresolution Analysis, we justify why it is correct to restrict the domain of definition of the continuous texture, formulate the concept of 3D-rigid motions of textures, and develop a method for computing 3D-rigid motion invariant texture signatures necessary for the texture classification. (Received September 08, 2009)