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**Robert Azencott** ([razencot@math.uh.edu](mailto:razencot@math.uh.edu)), Department of Mathematics, 651 Phillip G. Hoffman Hall, University of Houston, Houston, TX 77204-3008, **Saurabh Jain\*** ([sjain@math.uh.edu](mailto:sjain@math.uh.edu)), Department of Mathematics, 651 Phillip G. Hoffman Hall, University of Houston, Houston, TX 77204-3008, and **Manos Papadakis** ([mpapadak@math.uh.edu](mailto:mpapadak@math.uh.edu)), Department of Mathematics, 651 Phillip G. Hoffman Hall, University of Houston, Houston, TX 77204-3008. *Rigid Motion Invariant Classification of 3D-Textures*. Preliminary report.

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)