The emerging field of cancer radiomics endeavors to characterize intrinsic patterns of tumor phenotypes and surrogate markers of response by transforming medical images into objects that yield quantifiable summary statistics to which regression and machine learning algorithms may be applied for statistical interrogation. Recent literature has identified clinicopathological association based on textural features deriving from gray-level co-occurrence matrices (GLCM) which facilitate evaluations of gray-level spatial dependence within a delineated region of interest. GLCM-derived features, however, tend to contribute highly redundant information. Moreover, when reporting selected feature sets, investigators often fail to adjust for multiplicities and commonly fail to convey the predictive power of their findings. This article presents a Bayesian probabilistic modeling framework for the GLCM as a multivariate object as well as describes its application within a cancer detection context based on computed tomography. The methodology, which circumvents processing steps and avoids evaluations of reductive and highly correlated feature sets, uses latent Gaussian Markov random field structure to characterize spatial dependencies among GLCM cells and facilitates classification via predictive probability. Correctly predicting the underlying pathology of 81% of the adrenal lesions in our case study, the proposed method outperformed current practices which achieved a maximum accuracy of only 59%. Simulations and theory are presented to further elucidate this comparison as well as ascertain the utility of applying multivariate Gaussian spatial processes to GLCM objects.

KEYWORDS: Bayesian prediction; cancer detection; gray-level co-occurrence matrix; Markov random field; texture analysis