1. Introduction

Since the first introduction by Holland (1975), many forms of genetic algorithms (GA) have been continuously proposed for remote sensing applications: (i) image segmentation and classification (Tseng and Lai, 1999; Pal et al., 2001; Harvey et al., 2002; Liu et al., 2004; Bandyopadhyay, 2005); (ii) sub-pixel classification (Mertens et al., 2003); (iii) model optimization (Jin and Wang, 2001; Chen, 2003; Fang et al., 2003); (iv) image registration (Jones et al., 2000; Chalermwat et al., 2001); (v) pixel aggregation (Lu and Eriksson, 2000); and (vi) image band selection (Siedlecki and Sklansky, 1989; Lofy and Sklansky, 2001; Kavzoglu and Mather, 2002; Yu et al., 2002; Fang et al., 2003; Kooistra et al., 2003; Luo et al., 2003; Ulfarsson et al., 2003; Cogdill and Rippke, 2004). Ranking by the number of publications, using GA as band selectors is the most popular.

In general, band selectors help alleviate the problem of high-dimensional complexity (Bellman, 1961; Kendall, 1961; Hughes, 1968; Fukunaga, 1990; Shahshahani and Landgrebe, 1994) that usually affects the outcome of analyzing multiple band data (e.g. multisensors, multi-temporal, or hyperspectral images). In most cases, a large number of image bands (i.e. N20 bands) are too complex for familiar parametric tools (e.g. Jeffries–Matusita distance, Bhattacharyya distance, Maximum Likelihood classifier, etc.). Mathematically, the complexity of using such a large number of bands does not only decay the precision of class model estimation of these parametric tools (Bellman, 1961; Hughes, 1968), but it also causes the singularity of covariance matrix inversion (Fukunaga, 1990). Additionally, this high-dimensional complexity results in an excessive demand of field samples in which, in most cases, it is not feasible in practice due to the time and budget limitations (Shahshahani and Landgrebe, 1994).

By comparison, GA-based band selectors perform better than many other popular band selection algorithms (e.g. branch and bound search, exhaustive search, and sequential forward selection) (Siedlecki and Sklansky, 1989). The comparison has been rigorously done using a synthetic error model instead of real remotely sensed data so as to eliminate the variables (e.g. sample size, the number of spectral bands, the number of classes of interest, etc.) that could cause bias to the outcome of the comparison. In addition, mounting evidence of success of GA-based band selectors in real-life remote sensing applications are also found in recent literature: (i) selecting a subset of multiple sensor/date data for image classification (Lofy and Sklansky, 2001; Kavzoglu and Mather, 2002; Ulfarsson et al., 2003); (ii) selecting spectral bands that relate to physiochemical