2.2 Region Growing and Merging

The goal of region merging and region growing [16], [26] is to divide the domain R of the image I into regions $\{R_i : i = 1, ..., M\}$ so that $R = \cup_{i=1}^{M} R_i$, $R_i \cap R_j = \phi$ if $i \neq j$, and I satisfies a homogeneity criterion on each R_i.

Region merging builds up complicated regions by combining smaller regions using a statistical similarity test. A popular choice is Fisher's test [33]. For example, suppose there are two adjacent regions R_1 and R_2, where n_1, n_2, $\hat{\mu}_1$, $\hat{\mu}_2$, $\hat{\sigma}_1^2$, $\hat{\sigma}_2^2$ are the sizes, sample means, and sample variances of R_1, R_2, respectively. Then in order to decide whether or not to merge them, we can look at the squared *Fisher distance*:

$$\frac{(n_1 + n_2)(\hat{\mu}_1 - \hat{\mu}_2)^2}{n_1\hat{\sigma}_1^2 + n_2\hat{\sigma}_2^2} = \frac{n\hat{\sigma}^2}{n_1\hat{\sigma}_1^2 + n_2\hat{\sigma}_2^2} - 1, \tag{4}$$

where $n = n_1 + n_2$ and $\hat{\sigma}^2$ is the sample variance of the mixture region (a generalization to the multidimensional case is called Hotelling's test [17]). If this statistic is below a certain threshold then the regions are merged.

Region growing can be considered as a special case of region merging, where R_1 is the growing region and R_2 is a single pixel at the boundary of R_1, i.e., $n_2 = 1$ and n_1 is very large (say $n_1 > 100$). In this case we can treat $\mu = \hat{\mu}_1$, $\sigma^2 = \hat{\sigma}_1^2$, and $\mu_2 = I_{(x,y)}$ (the intensity at point (x, y)), and approximate the squared Fisher distance [8] by: $\frac{(I-\mu)^2}{\sigma^2}$.