Relationship Between the Sum of Squared Difference (SSD) and Cross Correlation for Template Matching

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In this note the relationship between sum of squared difference (SSD) and cross correlation template matching approaches are reviewed. SSD matching is defined as follows,

$$d(u,v) = \sum_{x,y} \Big(f(x,y) - t(x-u, y-v) \Big)^2 \tag{1}$$

and cross correlation,

$$c(u,v) = f(x,y)t(x-u, y-v) \tag{2}$$

where f is the image, t the template and summation is over positions x, y under the template positioned at u, v. SSD can be viewed as the squared Euclidean distance.

Expanding (1), yields,

$$d(u,v) = \sum_{x,y} f^2(x,y) - 2f(x,y)t(x-u, y-v) + t(x-u, y-v)^2. \tag{3}$$

Note that the term $\sum_{x,y} t(x-u, y-v)^2$ is constant. Assuming that the term $\sum_{x,y} f^2(x,y)$ (i.e., the local image energy) is approximately constant, the remaining term (i.e., cross correlation term)

$$c(u,v) = f(x,y)t(x-u, y-v) \tag{4}$$

is a measure of the similarity between the image and the template; the larger the value of c, the more similar the image and template are.