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SEGMENTATION OF TEXTURED IMAGES BY A MAXIMUM LIKELIHOOD CLASSIFIER USING MARKOV MESH AND GAUSSIAN JOINT DENSITY MODELS

ANTONIS IOANNIDIS

SASC Technologies, Inc.
Lanham, Maryland

DIMITRI KAZAKOS

Electrical Engineering Department
University of Virginia
Charlottesville, Virginia

ABSTRACT

We present a method for segmentation of images posessing appreciable texture information. This approach is developed for an image containing two independent textures forming a background and an object.

We model the image as a two dimensional array of random variables and form a viewing window which slides accross the image. We call this the "observation window". To express a boundary within the observation window, we form a series of "masking windows", each representing a boundary arrangement between the two textures. Masking windows are formed by the masking process $A_{i,j} = \{0, 1\}$, where 0 and 1 denote the origin of the random variable from background and object respectively.

We form the likelihood function as follows.

$$P(X) = \prod_{i=1}^{n} \prod_{j=1}^{n} P_1(X_{i,j}/V_{i,j})^{(1-A_{i,j})} * P_0(X_{i,j}/V_{i,j})^{(A_{i,j})}$$

where P (X) is the joint probability of pixel values in the observation window. Using the independence assumption between the textures we denote $P_0(X_{i,j}/V_{i,j})$ and $P_1(X_{i,j}/V_{i,j})$ as probabilities of pixel i,j dependent on a neigborhood $V_{i,j}$ and originating from texture 0 or 1. The classifier receives the pixel values within the observation window and tests the above likelihood function against each masking window by substituting the $A_{i,j}$ parmeter. The masking window which maximizes the likelihood function is selected.

Two models are used in the implementation of this likelihood function. In one, a third order Markov mesh model provides the transition probabilities of each random variable and its three neighbors. This model requires coarse quantization of the image in order to reduce the number of measured transition probabilities. The second model assumes that the picture elements are independent and identicaly distributed. When constrained further to Gaussian distributions, the likelihood function maximization is based on the mean and variance of the two textures inside the observation window.

A variety of textures were tested by both models. The Markov mesh model performed well in textures with primitive size close to the size of the 3rd order mesh, i.e. four neighboring pixels. The Gaussian joint density model performed very well in finely grained images as well as in environments where Gaussian noise had been added. Error performance of the classifying algorithm is currently under investigation.