Operations on Compressed Image Data

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In this paper, a formal framework of directly processing the encoded data is presented. Image operations which can be directly and efficiently applied on run-length encoded data are identified. The FSM and Attributed FSM models are used to describe these operations.

A Formal Model of Compressed Data Manipulation

Let $X = x_1 x_2 \ldots x_\ell$ be a string of input data with $x_i \in \mathcal{A}$, where $\mathcal{A}$ is the set of legal alphabet. Consider a coding scheme which compresses the data in two stages: transformation T such that $T(X) = Y$, $Y = y_1 y_2 \ldots y_m$ with $y_j \in \mathcal{B}$ where each entity in $\mathcal{B}$ contains a symbol with r attributes, i.e. $y_j = \{s_j, a_{j1}, a_{j2}, \ldots, a_{jr}\}$ and encoding E such that $E(Y) = Z$, where Z is the encoded data.

For a given image operation P, consider three algorithms which take the input strings X, Y, Z with time complexities $f_P(\ell)$, $g_P(m)$, and $h_P(n)$, respectively. We do not operate on Z due to obvious difficulties like identifying symbol boundaries in variable length coded data. We focus on manipulating Y which is the irredundant and decorrelated image data. Although performance of algorithms that manipulate Y are heavily data dependent, in many cases such algorithms are more efficient because $m \leq \ell$.

Manipulation of Run-Length Encoded Data

We have focussed on manipulating run-length encoded image data. 1-D operations studied include: Point Operations and Spatial Transformations *(Translation, Reflection, and Scaling)* which can be implemented using a FSM. Algebraic operations and 1-D convolution can be implemented using Attributed FSMs. The extension of the work to 2-D operations is considered. As an example of implementing 2-D operations by sequential processing of scan-lines, calculation of $(p + q)^{th}$ order moment of an image has been developed. It is known that "rotation" can be implemented as a set of horizontal followed by vertical translations. This property can be applied to other geometric operations. We show a possible decomposition of the bilinear spatial transformation into a sequence of translations namely horizontal, vertical, and horizontal translations in that order.

Possible extensions include identifying coding schemes which can be manipulated in the transformed domain and to develop coding schemes which lend themselves to efficient manipulation.