# Digital Image Library Data Design Criteria

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***Abstract* - Digital image libraries require design choices for various physical data characteristics (e.g., stored image resolution or visual display settings). Different kinds of design criteria can be identified based on these characteristics, depending where they are applicable in the overall system architecture (e.g., for human viewing or for image management). A succession of choices for different values of the criteria can be defined for different application cases. This paper gives a broad description of such a design approach, with an example.**

***Keywords* - digital image library; human visual system**

## I. INTRODUCTION

A digital image library is a special type of document database where analysis and organisation of the information must cater for human visual understanding. Design and construction of digital image libraries is a rapidly growing activity in online environments (e.g., fine art, museums, tourism). Their efficiency and usefulness depends on appropriate design decisions allowing a balance between fidelity for human viewing and computational performance for data handling. These decisions may be informed by categorizing the various system characteristics according to purpose and applying knowledge of the limits of the human visual system. We can apply this approach to match the design criteria to suit specific user objectives for the system, by specifying a set of values to give images with graded properties for different purposes. In this work we have concentrated on digital image libraries of conventional scanned photographic images, rather than fine detail or synthetic content such as documents or artworks. An example is provided for a typical digital image library case.

## II. DESIGN APPROACH

Appropriate design criteria for digital image libraries depend on numerous contextual considerations including complexity of the images, viewer recognition of content, ease of search and access, and protection of commercial interests. Previous work e.g. Frey [1] has suggested a wide range of such criteria, which may be interrelated. Here we suggest a high level systematic approach to group such criteria together, allowing the interrelationships to be made explicit. In developing this structure we should consider design criteria in two dimensions: *Psycho-physical Factors* related to visual perception behaviour and *Usage Stages* related to digital image library management functions.

### *A. Psycho-physical Factors*

These criteria are based on fundamental aspects of the human visual system, such as visual acuity, contrast sensitivity, colour constancy, visual attention. The "early vision" aspects of these are widely characterized in literature, but the effects of image content and quality are less conclusively understood. The concept of image "quality" [2] denotes the apparent noise in the image content which would disrupt pure visual information, while the concept of "attention" [3] indicates where information of interest to the user is located in an image. A method for combining these aspects together with low level vision components to map image "importance" has been developed [4] and applied to a range of visual characterization tasks, supported by more recent work on "interestingness" [5].

### *B. Usage Stages*

These criteria are based on the operations performed on digital images to support the use of the library. The basic concepts of Frey [1] are informative for this. It is necessary to use different forms of representation for images at the different stages, so that the different image management tasks are conducted with appropriate accuracy and ease. For instance, if choices for spatial and intensity factors are made at the time of the original digitization, these need not necessarily be preserved for image retention and presentation purposes. Nevertheless they need to be chosen to give sufficient data for any required image enhancement or content analysis operations to be performed before the image is incorporated in the library.

TABLE I. HIGH LEVEL DESIGN CRITERIA CLASSES

| Psycho-physical Factors | Usage Stages |
|---|---|
| *Spatial:* pixel density, spacing, aspect ratio, shape, size | *Input:* image capture by digital photography or scanning |
| *Intensity:* pixel brightness, contrast, colour values, gamut | *Process:* image enhancement, feature detection or emphasis |
| *Quality:* visual appearance sharpness, clarity, aliasing | *Store:* image formatting or compression to retain long term |
| *Inform:* visual information density, localization, spread | *Display:* image reconstruction, presentation on screen/print |

We define the high level classes of interest for design criteria within these two dimensions as shown in Table I. For a given digital image library situation, design choices must be made for each class of Factors, at each Stage. For instance, choice of spatial and intensity settings for the digitization at the input stage will be informed by the underlying quality of the original photographs, and how much information of interest the viewer would be able to see in them. Image sources such as amateur photographs will be lower in quality and information than studio photographs. Once digitized, images may be subject to enhancement and for storage purposes may be compressed: both these actions change physical characteristics but do not necessarily affect viewer perception of information content. When displayed or printed, values may need to be modified further to match the hardware available, which a user may see as differences in image quality and information content.

It is usual for digital image libraries to be configured so as to allow different forms of usage, depending on the needs and sophistication of the user. For example, small thumbnail image versions are used to allow for browsing or refinement of search. Larger image versions such as postcard size are used for inspection of individual images in the library, with the intention of analysis of the contents or decision to obtain a higher grade version by rescanning or restricted access mode or purchase through commercial interaction. Therefore it may be necessary to consider the design criteria successively for several different usage regimes in a digital image library, resulting in a nested sequence of implementation version, allowing easy generalization or specialization as the hierarchy is traversed.

## III. EXAMPLES

We consider a common application for digital image libraries: collections of portrait photographs. These may be used for "General Purpose" viewer interest modeled as small standard postcard sized prints (e.g., 150x100 mm), or "Special Purpose" subject/content identification modeled as enlargements (e.g., 200x150 mm or 300x200 mm).

Table II shows sample values for a General Purpose configuration of the portrait digital image library. As the quality of such photographs is generally quite modest, and the image content is quite simple in structure, the related quality and information factors suggest that spatial and intensity choices can be fairly coarse for the digitization without compromising the available detail. Different kinds of processing operations would be needed to improve some images and as a result the scanned resolution would be further reduced. Storage would be compressed at a high quality lossy rate, approaching "visually lossless". Images would be displayed on only part of the screen, and printed versions would be at postcard size.

Table III shows sample values for a Special Purpose configuration of the portrait digital image library. This would require original photographs of high quality and available as enlargements, allowing high quality initial digitization to capture as much of the inherent detail as possible. Little processing is needed once the images have been digitized due to the high quality of the photographs. Storage would use a lossless compression method which enabled the full size raw digitized image data to be preserved. Images would be displayed as full screen and printed versions would be at enlargement size.

## REFERENCES


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TABLE II. DESIGN CHOICES FOR GENERAL PURPOSE CONFIGURATION

| | **Input Stage** | **Process Stage** | **Storage Stage** | **Display Stage** |
|---|---|---|---|---|
| **Spatial Factor** | 200-300 dpi (1200x800 pixels) | 2:1 downsize (600x400 pixels) | 10:1 lossy (24K-36K) | 640 x 480 pixels |
| **Intensity Factor** | 8-bit | 8-bit warp | 8-bit lookup | 8-bit lookup |
| **Quality Factor** | Mid | Mid | Low | Low |
| **Inform Factor** | Low | Low | Mid | Mid |

TABLE III. DESIGN CHOICES FOR SPECIAL PURPOSE CONFIGURATION

| | **Input Stage** | **Process Stage** | **Storage Stage** | **Display Stage** |
|---|---|---|---|---|
| **Spatial Factor** | 300-600 dpi (3600x2400 pixels) | 1:1 fullsize (3600x2400 pixels) | 4:1 lossless (4M-16M) | 3Kx2K pixels |
| **Intensity Factor** | 3x16-bit | 3x8-bit warp | 16-bit lookup | 8-bit lookup |
| **Quality Factor** | High | High | High | High |
| **Inform Factor** | Mid | Mid | High | High |