The Restoration, Enhancement, and Desk-top Printing of Archival Photographs

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Abstract

With the accelerating pace of digital imaging, and the growing importance of consumer desk-top printing, one practical application that is easily overlooked concerns the digitization, restoration, enhancement, and printing of archival photographs. This field is now also made possible by the widespread availability of high-resolution scanners. The author reports on his experience in this field, based on the restoration of several hundred historical photographs, during which time a set of simple ad hoc restoration and enhancement recipes were developed.

Introduction

In addition to the collections of historical photographs held by large organizations, museums and galleries, there are vast numbers of old family photographs in the possession of individuals, many dating back to the late 1800s. The majority of these remain victims of the frustration associated with the well-known 'shoe-box' syndrome. However there is the growing awareness of the practicality and pervasiveness of newer digital technologies, which not only allows image enhancement and restoration, but also permits the subsequent distribution of high-quality prints and web-images among a much wider audience.

The principal practical impediment is due mainly to the lack of the availability of user-friendly consumer hardware and software. For those applications requiring high image-quality, simple desk-top scanners and printers can often produce satisfactory results, yet require a degree of consumer familiarity which may be beyond the average user. At the same time most existing software typically ranges between the primitive or the prohibitively complex in operation. However the number of essential steps in a typical end-to-end restoration process is quite limited and in principle could readily be reduced to the combination of a simple set of recipes within a user-friendly consumer software package.

The author reports on his own experience within this applied field of consumer digital-imaging, and presents examples whereby in some cases important but deteriorated photographs can be restored to a quality satisfactory for widespread dissemination and printing.

Digital Image Enhancement

In any applied image-enhancement context, including the present one, the existence and availability of a critical set of image processing tools become of paramount importance. For the restoration of old photographs, this image processing capability should be much the same as that for any other area of consumer pictorial imaging.

While various 'off-the shelf' software packages are readily available, in general these are as yet too complex for routine consumer application in either this or any other home-based digital-imaging application. Even the more sophisticated of these software packages tends to have a proliferation of available controls and manipulations with descriptions not necessarily readily translatable into easily understandable photographic effects, and typically not presented in any simple hierarchy of independent operations. As just one example, there is the widespread interchangeable use of the term 'contrast' to indicate any one of several image properties that are only loosely related.

On the other hand, the number of typical image-processing steps required for restoring old photographs is relatively few. Furthermore, if organized within a systematic hierarchy and limited to the practical ranges encountered within any application, the overall procedure can be reduced to a fairly straightforward recipe. Stated in the most general terms, this can be expressed by a set of sequential image-processing operations, as listed below.

Basic Image-Enhancement Steps
Macroscopic
1. Optimize global pixel mapping
2. Rebalance pixel map for global visibility
3. Optimize global tone balance

Microscopic
4. Rebalance local tone visibility
5. Optimize local detail

Whereas most image-processing software tool-kits implicitly contain most or all of these operations, typically they are presented in a complex, interconnected manner, with no opportunity to unbundled them in any systematic way. Likewise, little or no help is given to indicate the logical sequence in which they should be applied.

In the ideal case for simple and routine consumer use, each of these independent hierarchal controls would be

associated with a controlled single variable, say a calibrated 'slider' covering the practical gamut of values, for which equal interval-change equates with equal change of visual impression. The existence of such a set of controlled variables would then eliminate the time-consuming frustrations of trial-and-errors manipulations.

Those image-processing controls involving global change on the macroscopic scale are readily straightforward, at least in concept, though not necessarily in existing software packages. Regarding a minimum set of controls involving local changes on the microscopic scale, the author has previously described his own attempts to define such an image-processing capability.[1,2] These relate to what is described above as the rebalancing of the local tone-visibility, and the availability of a novel continuously-variable edge-enhancement algorithm.

Both these enhancement routines were developed using well-known spatial-frequency characteristics of the human visual system as relevant under typical conditions of viewing consumer images, and hence are ideally suited for this purpose, as for most others.

Practical Procedure

The author has assembled a basic hierarchal set of image processing recipes that best approximate the criteria described above, with approximately five independent controls available for use on any individual picture. This set was assembled on the basis of experience gained during the attempted restoration and enhancement of several hundred pre-1920 photographs, many dating back into the 1870s.

Several observations are appropriate at this stage. First, since the exercise was started with the express purpose of reducing the problem to a routine process, an initial arbitrary but realistic target was that of a successful 'two-minute' enhancement procedure. Second, a large number of old photographs have been subjected to various sources of damage, deterioration and decay, and whereas the repair of such images is often within modern digital technology, such custom repair cannot be included within any such simple procedure. Finally, problems encountered with image resolution and color reproduction are typically absent in this application, since the majority of such pictures were taken using large-format cameras and reproduced in monotones (although, for example, re-toning in say, an approximation to traditional sepia-tones may play an important role in the overall enhancement routine).

Figure 1 shows an illustration of a well-known historical image used as a test-sample during the evolution of the enhancement procedure. The copy chosen as the 'standard original' needed each of the hierarchal procedures described above, and was challenging and atypical, in that the last and least of these (local detail image enhancement) played a major role in the final result. Such a facility is not generally available in consumer software packages.

In this illustration, as in all others shown here, it should be stressed that the images were optimized based on visual assessment criteria for web-display and high-quality desk-top printing, and the reproductions printed here can be no more than generally indicative of the changes effected during routine enhancement.

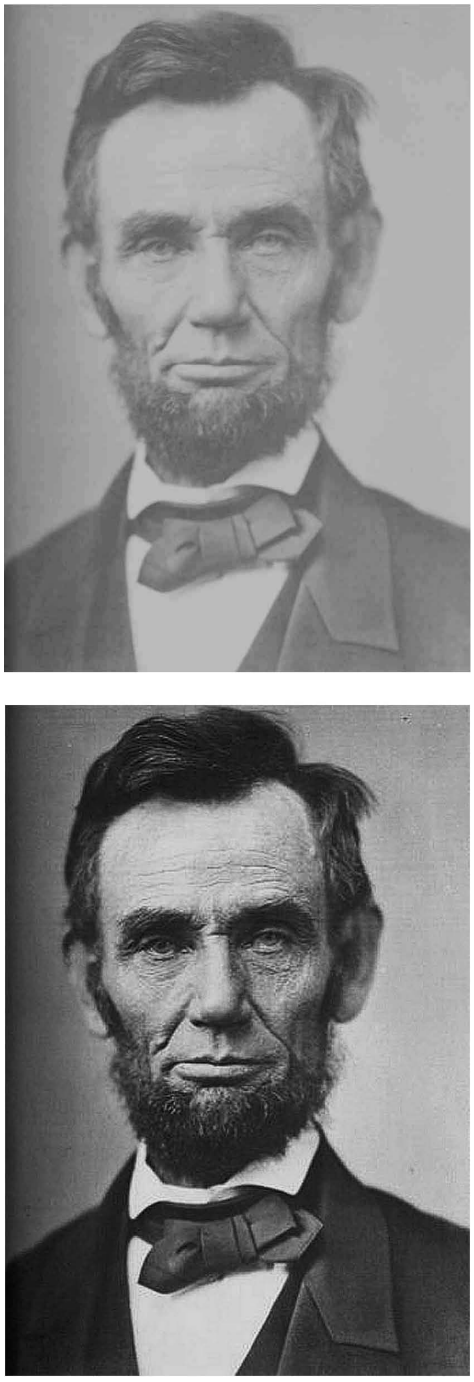

Figure 1. Example of a faded image before-and-after routine image enhancement

A more representative photograph as taken from typical personal family archives is illustrated below in Figure 2. This archival 1890s portrait was enhanced from marginal quality in the original to the point where it was suitable for printing and distribution throughout a wide network.

Other typical restorations are shown in Figs 3, 4 &5 (although not within the general scope of this study, Fig 5 illustrates the simplest type of photograph requiring an initial elementary 'repair').

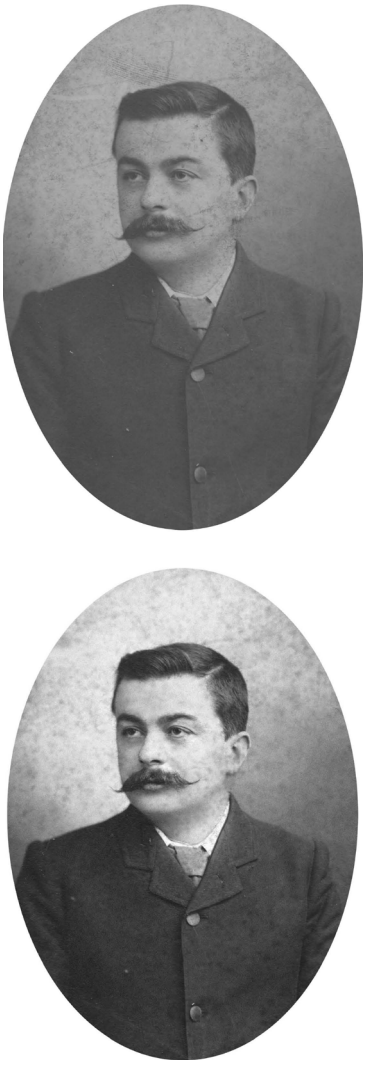

Figure 2. A restored archival portrait, circa 1895.

It is estimated that there may be more than a billion old photographs in private possession in the US alone. These no doubt cover the full gamut of scene types and range from those of general interest to a wide audience and those of local interest within, say, a family or specific interest group. Providing technical help to this large consumer group would not only provide a useful service, but also no doubt extend digital-printing into wider, profitable fields.

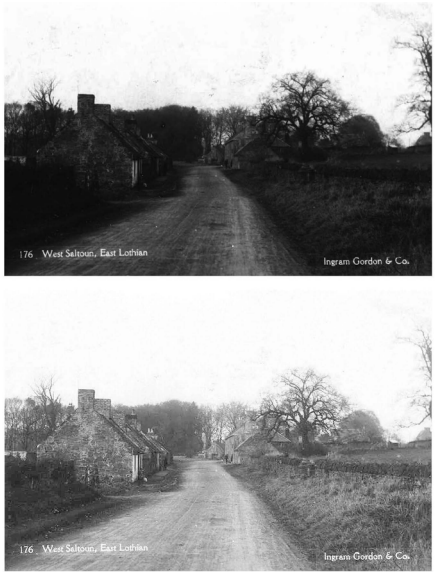

Figure 3. Local tone enhancement of an old post-card

Figure 4. Family group restored to high print quality

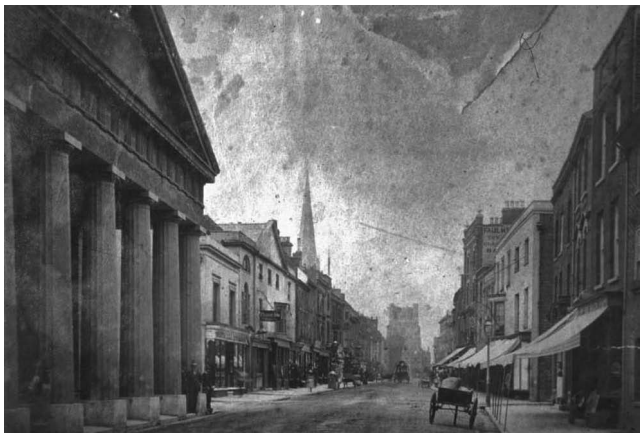

Figure 5a. Damaged city photograph

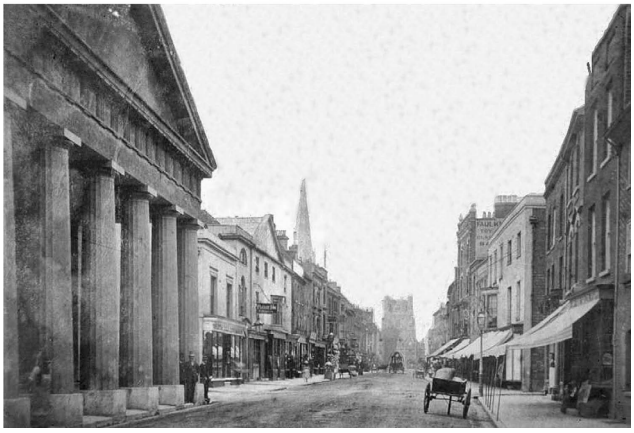

Figure 5b. Repaired and enhanced version

Summary and Conclusions

The author has demonstrated a simple, user-friendly approach to the restoration and enhancement of archival photographs. The number of processing stages has been reduced to a hierarchal set of fundamental operations, which could in principal be reduced to a set of basic calibrated 'sliders' for routine consumer use. Such simplification would allow large numbers of typical old photographs to be enhanced to a quality-level satisfactory to the majority of consumers.

References

1. R. Shaw, IS&T Procs. NIP 15, 2001, pg 705.
2. R. Shaw, IS&T Procs. NIP 18, 2002, pg 595.

Biography

Rodney Shaw received a PhD in physics from Cambridge University. After several research and teaching positions in the UK and Europe he came to the USA in 1973, and following research appointments at Xerox and Eastman Kodak was Director of the Center for Imaging Science at RIT. Following this he spent a decade at H-P Labs. His current interests are in digital systems optimization, and especially the reduction of image processing algorithms to routine consumer use. The recipient of many honors and awards, and the author of more than a hundred publications, in 2002 he was awarded Honorary Membership in IS&T. rodshaw@usa.com