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Fulfill Your Digital Preservation Goals with a Budget Studio

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Abstract

In order to fulfill digital preservation goals, many institutions use high-end scanners for in-house digitization of historical print and oversize materials. However, high-end scanners' prices do not fit in many small institutions' budget. As digital single-lens reflex (DSLR) camera technologies advance and camera prices drop quickly, a budget photography studio can help to achieve institutions' preservation goals. This paper compares images delivered by a high-end overhead scanner and a consumer level DSLR camera, discusses pros and cons of using each method, demonstrates how to set up a cost efficient shooting studio, and presents a budget estimate for a studio.

Literature Review

There are many online guidelines and manuals for digitizing print materials. Some universities and museums have information about their digitization equipment online. Most articles focus on either high-end scanners or customized scanning stations. These articles are very helpful for universities and museums that are relatively well funded. However, there is almost no literature discussing how to use inexpensive digital cameras and photography equipment to produce high quality digitized images. This article will use a case study to prove that a low budget studio can produce high quality digitized images.

Problem & Motivation

Colorado State University Libraries (CSUL) are regularly engaged in a variety of digitization projects. Materials for some projects are digitized in-house, while items from selected projects are sometimes outsourced. Most fragile materials that require professional handling are digitized in-house using an expensive overhead scanner. However, the overhead scanner has been occasionally unstable since it was purchased in 2007, and this has been delaying some of our digitization projects. While the maintenance fee of the overhead scanner rises each year and its technology getting outdated, prices of DSLR cameras drop quickly and their image qualities improve greatly.

Being enthusiastic about photography, the author decided to compare images produced by the overhead scanner and a consumer level DSLR camera side-by-side. The paper lists pros and cons of using each method; illustrates how to establish a shooting studio; and presents a budget estimate for the studio.

Approach

Tested materials include historical books' illustrations and text, photographs, oversize maps, and small prints. Images' qualities are compared both on computer screens and in prints.

The test camera set is chosen because it is the one the author uses for general purpose. It is also chosen by many professional photographers because of its quality and affordability. To avoid dispute, the overhead scanner's make and model are not revealed.

Table 1: Test equipment

Budget Studio:	*Overhead Scanner:*
1. Nikon D800 DSLR camera 2. Nikon Macro 60mm lens 3. Manfrotto 055CXPRO3 Carbon Fiber Tripod Legs 4. BH-40 LR II Ballhead 5. Non-reflective glass 6. Book cradles 7. X-Rite ColorChecker Card 8. Natural daylight Total cost: $4,500 and no maintenance fees (priced in 2014)	1. Our overhead scanner 2. Non-reflective glass 3. Book cradles 4. Purchase price: $55,000 (purchase in 2007) $8,000 annual maintenance

Results

This article demonstrates that a low budget studio can produce high quality digitized images and even produce superior images compared to images scanned by our expensive overhead scanner.

Historical Book Illustration Comparison

A 1852 book is used for this test. In the following figure, both images were originals and have not been enhanced by software. In addition to this image, we tested other nine illustrations. Following our comparison study, we concluded that a semi-professional DSLR camera produces sharper images than our expensive overhead scanner.

Figure 1. *At zoom 200% level, the left image shows much more detail than the right image. The left image was taken using a Nikon D800 and the right image was produced by our overhead scanner. Samuel M. Janney, The Life of William Penn; with Selections from His Correspondence and Auto-Biography (Philadelphia: Hogan Perkins & CO, 1852) Un-number plate before the title page. Print.*

Text

At CSUL, the process of digitizing a text document includes scanning, converting them into Portable Document Format (PDF) files, and applying an OCR process.

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In general, a well-focused image of text produces better OCR results, although software such as Adobe Acrobat can tolerate fuzzy images and produce reasonably accurate OCR text. Our OCR tests from a slightly out-of-focus image and a well-focused image have no significant difference; however, from preservation and usability standpoints, we prefer well-focused images.

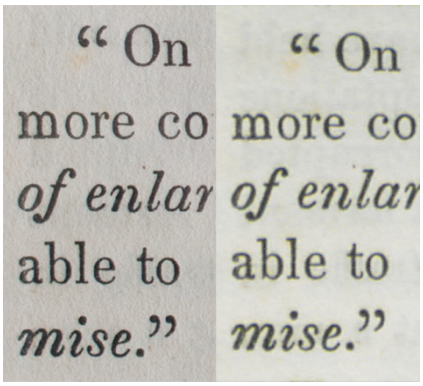

Figure 2. *The left image was produced by our test DSLR camera and has a better focus. The right image was produced by our overhead scanner. Samuel M. Janney, The Life of William Penn; with Selections from His Correspondence and Auto-Biography (Philadelphia: Hogan Perkins & CO, 1852), page 300. Print. Photograph*

A 6.5 inches by 4.5 inches silver print is used for this test. Our tests show that the test DSLR camera produced a sharper image of this historic photograph.

Figure 3. *Screen view of at zoom 100% of a silver print. The top image was produced by the test DSLR camera and the bottom one was produced by our overhead scanner. Historical photograph from Colorado State University Archives and Special Collections.*

Oversize materials

A 25 inches by 26 inches map is used for this test. Our overhead scanner’s maximum scanning area is 24 inches by 17 inches. Therefore the map had to be scanned in four sections and stitch them together using Adobe Photoshop. The final image has good image quality and reveal more details than the image produced by the test camera. However the stitching process is extremely slow because of large file sizes of section images. Also stitching images is not recommended because there are always some degrees of mismatching errors created by lens distortion.

A camera can capture any material size, but the details of the photographed images diminish as the material’s size increases. The image produced by camera has a lower resolution and less detail. Both devices have their drawbacks, so we do not think either option would be ideal for oversized materials for now.

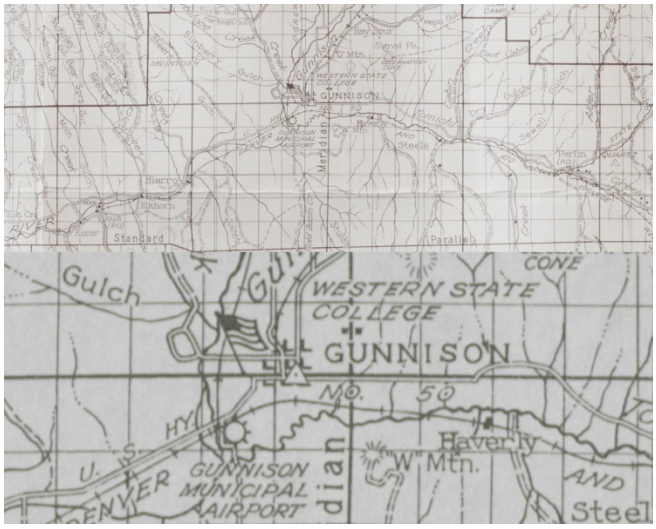

Figure 4. *Oversized materials screen view at zoom 100%. The top image was photographed by the test DSLR. The bottom image was scanned by our overhead scanner. Historical map from Colorado State University Archives and Special Collections.*

Small prints

One big advantage of a DSLR camera is that it can be set farther away to take pictures of oversized materials or very close to smaller objects to take close-up pictures. Comparatively, the distance of lens and scanning platform on our overhead scanner is fixed, so no close-up images can be produced, and everything is reproduced at scale of 1:1.

We used a 5.5 inches by 3.5 inches drawing for this test. The image produced by our overhead scanner has a resolution of 3427 pixels by 2103 pixels. The camera produces a 6776 pixels by 4240 pixels image. The higher pixel count allows users to see more details at the same zoom level. The image produced by camera is not only sharper but also contains more details. It also is good for making enlarged prints for promotion materials.

Figure 5. *Small prints screen view at zoom 100%. The left image is produced by a DSLR with a macro lens and the right image was scanned by our overhead scanner. A historical booklet from Colorado State University Archives and Special Collections.*

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Post Processing

Use of a Sharpening Filter

Our tests showed that a main drawback of our overhead scanner is that images produced are out-of-focus. Some digitization guidelines recommend minor post-processing for delivered images files to improve image quality. One might argue that to fix our overhead scanner's out-of-focus problem, sharpening can be applied. Also the Technical Guidelines for Digitizing Cultural Heritage Materials: Creation of Raster Image Master Files recommends doing minor post-scan adjustment to optimize image quality and bring all images to a common rendition. This is good advice, but it is not applicable in real-world practice. In order to get the best result, each image would need to be evaluated and have a sharpening filter applied separately, because when an improper sharpening setting is applied to an image, it often creates haloing artifacts and an unnatural look. The application of a sharpening filter to each image process will be extremely time-consuming.

The haloing artifact is also called Chromatic Aberration Effect. Chromatic aberration (CA) appears as unsightly color fringes near high contrast edges. Chromatic aberrations are typically only visible when viewing the image on-screen at higher zoom levels or on large prints.

The following example shows that the Chromatic Aberration Effect may not appear at lower zoom levels, such as 50% or 100%. The left image has no sharpening filter applied and the right image has a sharpening filter applied. At zoom 100%, chromatic aberration is almost not identifiable, and the right image appears to be superior in turns of sharpness.

Figure 6. *Sharpening filter comparison sample at the zoom level 100%. The left image has no sharpening filter applied and the right image has been applied a sharpening filter. A historical booklet from Colorado State University Archives and Special Collections.*

At a higher zoom level, we see chromatic aberration, visible in the right image of figure 7. The extra colors are introduced by the software. We recommend not applying sharpening filters to original scanned images; instead, attempt to obtain well-focused images from the beginning. For this reason, the test DSLR camera out-performed our overhead scanner for most materials.

Figure 7. *Comparison of sharpening filter applied to images and at zoom 500%. The left image has no sharpening filter applied and the right image has sharpening filter applied.*

Color Balance

When scanning or photographing an image under different lighting, the output image can have very different colors.

In the following figure, the left image was shot at a correct white balance setting. White balance (WB) is the process of removing unrealistic color casts, so that objects which appear white in person are rendered white in your photo [1]. The center one has a blue color cast which was caused by a lower Kelvin setting, and the right image was shot at a higher Kelvin setting. A camera may create images with the wrong colors, but so will a scanner if it is not calibrated correctly.

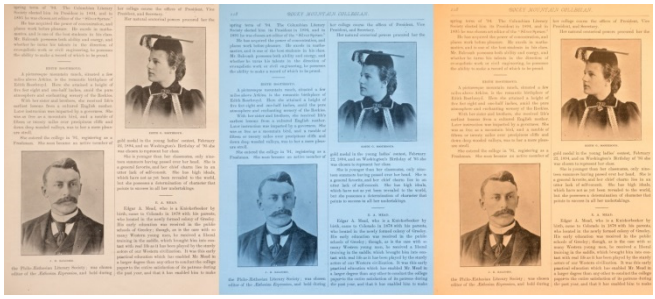

Figure 8. *Images shot under different white balance settings. Rocky Mountain Collegian, 1893, Vol 3-4, page 118, Colorado State University Archives and Special Collections.*

CSUL employees are not certified to calibrate our overhead scanner, we only use the prescribed settings set by technicians. In general, image colors rendered by the machine are close to original colors but not exact. Also we have no control over maintaining a fading light bulb, which will impact correct exposure.

White balance adjustment on digital photographs can be very precise if a proper workflow is followed. Professional photographers do test shots at the beginning of each shooting session. Once they found the optimal test shot, they will use the exact settings for the batch. Later, they will do minor color adjustment on the chosen test shot to ensure precise color representation, and then apply the adjustment settings on all other photos using a batch process.

ColorChecker Passport is a commercial product to help with quick and easy capture of accurate colors. I will demonstrate briefly a very useful trick I learned from a professional

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photography seminar how to utilize ColorChecker Passport to apply correct white balance a group of images.

Step 1: Place a 18% gray card or a ColorChecker Passport card on top of a page. Choose the correct exposure and take the photo and use the same exposure setting to take additional photos.

Step 2: In Adobe Lightroom, select the test target image and switch to develop mode. Select the White Balance Tool, move cursor over a gray area, try to find a spot with R G B values are very close. If you can find a place with equal R G B values, it will be ideal. This simple click will set the test image's white balance to an almost perfect setting.

Step 3. Synchronize other images' settings with the target image. Select the target image and all other images, click on Sync button, and select settings you would like to synchronize. Make sure the white balance button is checked.

Figure 9. *Synchronized images with correct white balance. Rocky Mountain Collegian, 1893, Vol 3-4, page 118, Colorado State University Archives and Special Collections.*

Recently, I had the opportunity to visit the Spencer Museum of Art's digitization lab. They have a different workflow to ensure even more scientifically correct colors. If you are interested in their approach, you can contact their Information Technology Manager or Photographer.

Sample budget studio setup

A digitization lab can have three rooms or areas, one for oversized materials, one for smaller prints or 3-D objects, and one for computers.

The area for shooting oversized materials should have black walls and floor. You can either use one flash light to bounce light off the ceiling or use two flash lights to shine lights directly onto the materials. For fragile materials, the first approach is more appropriate.The area for shooting smaller prints or 3-D objects should have a stable table and black or white background paper. For this room or area, black walls and floor are not required.

The following set of shooting equipment is recommended by photographers from the University of Kansas Spencer Museum of Art.

1. DSLR camera: Nikon D810/$2,799.95
2. Macro lens: Nikon AF Micro-Nikkor 60mm f/2.8D/$429
3. Heavy duty mono stand: Arkay 6JRCW Mono Stand Jr with Counter Weight 6'/$678.50
4. Strobe: Broncolor G2 Pulso 1600 Watt/Second Focusing Lamphead with 16' Cord/$3,053.68
5. Power pack: Broncolor Senso A4 2,400W/s Power Pack/$3,629.92
6. Reflector: Broncolor P65 Reflector, 65 Degrees, 11" Diameter, for Broncolor Pulso 8, Twin and HMI/$513.52
7. Reflector: Broncolor Softlight Reflector, 20" Diameter, for Broncolor Primo, Pulso 2/4 & HMI Heads/$501.76
8. Light Stand:Impact Air-Cushioned Light Stand/$44.99
9. Light meter: Sekonic L-308S Flashmate - Digital Incident, Reflected and Flash Light Meter/$199
10. Book cradle: Book Exhibition Cradles/$30
11. Background paper:Savage Seamless Background Paper (Both white and black)/$45 x 2 = 90
12. Non-reflective glass:1/4" Optiwhite Starphire Purified Tempered Single Lite Clear Class/$75
13. White balancing accessory: X-Rite Original ColorChecker Card/$69
14. Software:Adobe Lightroom 5/$150

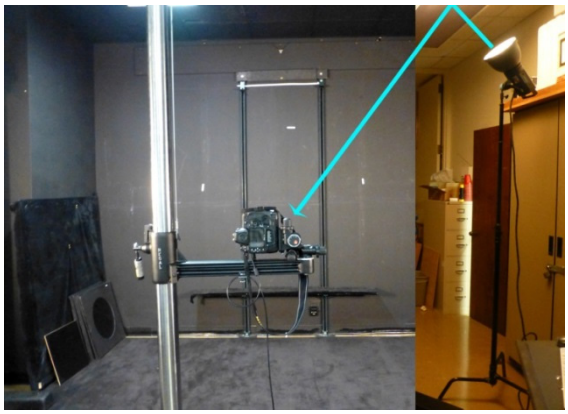

Figure 10. *The University of Kansas Spencer Museum of Art digitization lab setup for oversized materials.*

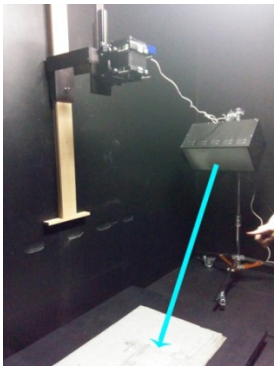

Figure 11. *Steelworks Museum of Industry and Culture's digitization lab setup for oversized materials.*

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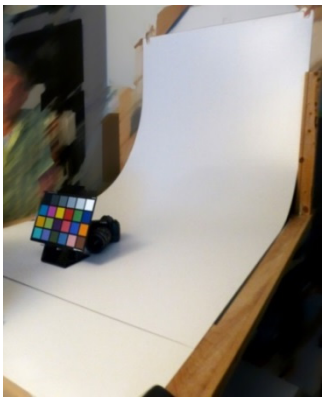

Figure 12. *The University of Kansas Spencer Museum of Art digitization lab setup for smaller prints and 3-D objects*

Figure 13*. Steelworks Center of the West's digitization lab setup for 3-D objects.*

The total cost for a budget shooting studio ranges from $10,000 to $15,000, and there is no annual maintenance expense.

Many librarians believe that digitizing print materials using a digital camera requires a professional photographer, but this is not necessarily true. A professional photographer or even an art student can act as a consultant to help set up a shooting studio and provide basic training. Also many museums have professional photographers and have set up shooting studios for digitization. They are very willing to share their experience and even provide training. I believe the learning curve for operating a shooting studio is no greater than the learning curve to operate an overhead scanner machine and its software.

Functions of some elements in the sample shooting studio

1. Macro Lens: It allows close up shooting of objects. It is especially useful when photograph small prints and small 3-D objects. It can also be used to photograph regular and oversized materials.
2. Heavy duty mono stand: It replaces a traditional tripod. It is very stable and allows quick adjustment of camera height and location.
3. Strobe, power pack and reflector: Together they generate consistent and homogeneous light distribution. Recommended further reading: Introduction To Off-Camera Flash: Three Main Choices in Strobe Lighting [2].
4. Light stand: It holds strobe and reflector.
5. Light meter: Hand-held exposure meters measure light falling onto a light-sensitive cell and converts it into a reading that enables the correct shutter speed and or lens aperture settings to be made [3].
6. Book cradles: They help to minimize the stress on book bindings and minimize page curvature problem.
7. Non-reflective glass: It helps to flatten a photographed page and reduce the reflection. However it does not completely eliminate glass reflection. One very useful trick to completely "eliminate" glass reflection is to place a black board with a hole above a page and shoot through the hole. This approach actually does not eliminate reflection but reflect black to the photograph. When the photograph is reviewed on computer, it will appear as no reflection has occurred.

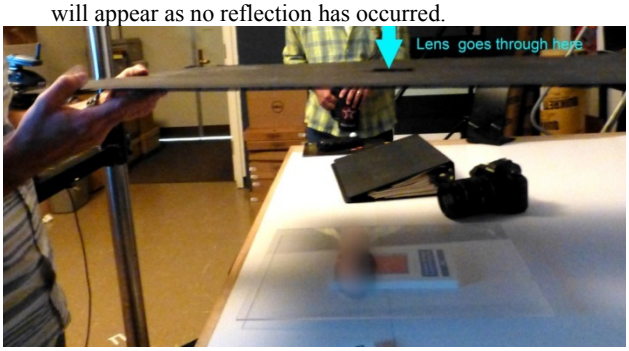

Figure 14. *The University of Kansas Spencer Museum of Art digitization lab setup for materials needed be pressed down by a glass.*

Pros and Cons

No digitization equipment or system is perfect. They all have trade-offs in regard to image quality, speed, convenience of use, quality of accompanying software, and cost. Our tests show that for most archival materials a DSLR camera will do a better job than an overhead scanner.

Pros of Overhead Scanner

1. The scanner is a complete scanning station. It can be connected to a computer and starts scanning immediately. Materials can be placed on the scanning surface, so no equipment adjustments are required while scanning.
2. It can scan and save images in bitmap format directly, while a DSLR camera can only shoot in grayscale or color.
3. Built-in book cradles help to scan thick books and those that cannot be fully opened.
4. Book curve correction functionality is provided by the accompanying software.
5. Cons of Overhead Scanner
6. High cost. The overhead scanner we have cost over $50,000, with an annual maintenance contract of $8000.
7. High replacement cost. When a scanner is outdated or broken, the entire machine has to be replaced.
8. Instability. Our overhead scanner is unstable even when placed on a sturdy table and handled only by professionals. From April 2010 to October 2010, the scanner was down for a total of 42 working days, 60 calendar days. The company fixed the machine onsite many times, but it continues to have minor problems and has not been 100% reliable.
9. The auto focus feature does not work consistently.

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10. Special training is needed to operate the machine and associated software.
11. File formats supported are limited. Most scanners only support TIFF, JPEG, JPEG 2000, Windows BMP, and PNG.
12. Unsupported outdated software: Our overhead scanner's software can only be run on an older operating system, Windows XP, because there is no updated software for this model.

Pros of Budget Studio

1. Stable. Under normal use DSLR cameras are much less likely to break down than scanners. For example, I have had an older DSLR, Nikon D200, for 7 years. It has survived numerous backpacking trips, multiple drops, and extreme weather conditions. The camera still functions as needed.
2. Fast and accurate focus. DSLR cameras are designed to focus quickly, and their focus indicators provide instant feedback to the operators so they know that the image is focused. If operated properly, images delivered by DSLR cameras can be sharper than ones delivered by scanners.
3. Less expensive. A good quality DSLR camera and a lens can be purchased for less than $4000 and last for years. As technologies advance, DSLR cameras' prices will continue to drop.
4. Ability to save files in more formats. In addition to TIFF and JPEG formats, most DSLR cameras can save photos in a raw file format. Some cameras can directly save images in Digital Negative (DNG) format and others deliver images in proprietary formats but can be converted into DNG using computer program. Editing RAW images is non-destructive, while editing of TIFF and JPEG images is irreversible.
5. Accurate white balance and exposure. By using right shooting and post processing techniques, photographs can have exact color reproduction. On the other hand, calibrating an overhead scanner most likely can only be performed by a company's trained technician. Proper exposure and white balance are not guaranteed.
6. The RAW file format usually provides more dynamic range. Overexposed and underexposed images can be fixed by adjusting exposure compensation via software; thus, lost shadow or highlight detail can be restored.
7. Can photograph three-dimensional objects. Archival collections often have materials other than books, such as art pieces. These materials are better to be photographed than scanned.
8. Versatile. Cameras can perform on-site digitization, while overhead scanners are too bulky to be moved around.
9. Faster and better preview. Images can be viewed instantly on a computer when proper software, such as Adobe Lightroom, is used. Operators can compare multiple shoots on a screen side-by-side and decide which photo to retain.
10. More accessible technical support. The number of DSLR camera users is much higher than overhead scanner users. Technical questions can often be answered through online forums.
11. Easy to find replacement parts. When a piece in a shooting studio break down, it is easy to find replacement piece and replace by staff.
12. Easy software updates. Software used in a studio is independent from equipment.
13. Cons of Budget Studio
14. There is learning curve for setting up a shooting studio, operating the studio, and mastering new image processing techniques.
15. A DSLR camera with a lower pixel setting will not be sufficient for scanning large format materials, such as posters and maps.
16. Security concern: Since a DSLR camera is highly portable, it can be stolen easily.
17. No built-in book curve correction is provided by Adobe Photoshop or Lightroom. However, our experience proves that the automatic book curve function does not always work well. We normally use a home-made book cradle to help lay a page flat and use one or two weights to hold down the other side of book. For some books, if flatness is hard to achieve, we place a piece of glass on the top to ensure the flatness.

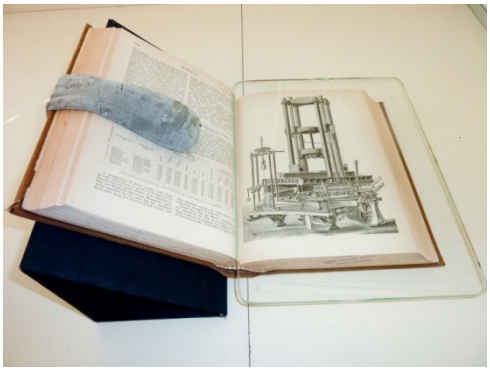

Figure 15. *Scanning set up using a book cradle.*

Conclusions

The technology of DSLR cameras has advanced very quickly in the past 10 years. Newer DSLR cameras can handle higher resolutions and have very little image noise even at a high ISO setting. The higher demand for DSLR cameras and accompanying image editing software results in more rapid technology advances compared to low-demand and high-end overhead scanners. High consumer demand drives DSLR camera prices much lower than prices for overhead scanners. In addition, the wide range of consumers purchasing DSLR cameras and software prompts companies to offer more user-friendly interfaces. As you can see from our tests, for most library materials a DSLR camera can produce superior images. If you do not have a budget for high-end overhead scanners, you can still fulfill your digitization preservation goals with a budget studio.

References

[1] "Tutorials: White Balance." Cambridge in Colour, http://www.cambridgeincolour.com/tutorials/white-balance.htm (accessed May 27, 2015).

[2] Tony Roslund, "Introduction To Off-Camera Flash: Three Main Choices in Strobe Lighting." Fstoppers. Fstoppers, last modified October 10, 2014, accessed May 27, 2015, https://fstoppers.com/originals/introduction-camera-flash-three-main-choices-strobe-lighting-40364.

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[3] "Introduction to Light Meters." B&H Foto & Electronics Corp., accessed May 27, 2015 http://www.bhphotovideo.com/find/Product_Resources/lightmeters1.jsp.

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Author Biography

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