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Leaf casting is one of the methods in the paper conservator's repertoire of preservation techniques. When appropriate, the method provides an effective way of treating fragile or damaged material. The key to achieving aesthetically and mechanically satisfactory results is in using the proper amount of paper pulp slurry, which requires an accurate measurement of the area of paper to be created. A computer-based video digitizer system for improving the speed and accuracy of the area measurement has been developed with the support of the Folger Shakespeare Library, and is currently in use in the Conservation Department. The basic system elements are a black and white camera and a video digitizer interfaced to a small computer, complemented by customized software which performs the area measurement and assists in the computations needed to specify the volume of slurry solution to be used.

LEAF CASTING

The purpose of leaf casting is to mechanically stabilize paper that is weakened due to holes, ragged borders, or other such reasons. The process creates new paper at the holes and edges, to a final size determined by the conservator.

The leaf casting process involves placing the page(s) to be treated over a filter screen in a special tank. Paper pulp suspended in a slurry is added to the tank and the liquid is drawn through the filter by means of a suction pump. The filter screen size is such that the pulp cannot pass through it. Since the fluid is drawn away only through the spaces where there is no paper, pulp is deposited on the screen only in those places. When dried, the newly created paper binds to the original paper and a uniform stable sheet is produced. Mattes are used to define the working area so that one large tank can accommodate single or multiple pages of varying sizes.

The key to successful leaf casting is in the determination of how much pulp

slurry to use. Ideally, there should be just enough pulp to fill in the missing paper areas to the same thickness as the original page. Too little or too much pulp results in a mechanically and aesthetically unsatisfactory final product. In order to know how much slurry to use it is necessary to determine the area and thickness of paper to be created. Thickness is simply measured with a micrometer.

Until the development of the computer-based system the method for determining the amount of pulp needed for the leaf casting operation was as follows:

1. Place the page over a grid and count the number of grid squares exposed by holes or uneven edges, giving you the area of paper to be replaced.

2. Measure the paper thickness with a micrometer.

3. Multiply the results of (1) and (2) above to determine the volume of replacement paper needed.

Step (1) was the major problem of the process. The manual counting was tedious and time-consuming. The unevenness of the ragged edges and hole borders forced one to make approximations in the grid square count. The result was that the overall process was a time drain with an unnecessary amount of unsatisfactory final products.

With the new system the burden of the work is placed on the computer. The conservator must still measure the paper thickness manually (step 2), but the area measurement and the calculations are now performed automatically.

VIDEO DIGITIZER SYSTEM

In order to measure an area with the computer, the image of that area must be stored in the computer. This is the function of the video digitizer. A video digitizer “captures” a standard television camera image, converting it from an analog form consisting of electrical signals of varying voltage into a digital data format that the computer can store, display, and manipulate. Once in the computer the image consists of individual dots (pixels, in computer jargon, for picture elements) on the monitor screen. The pixels are either white or black, depending on the brightness of the corresponding points in the original image. In the system used for the application, the computer uses 61,440 pixels to reproduce the image.

There are many different types of digitizers available on the market, for use with different computers and with different levels of capabilities (e.g., speed, levels of grey, colors, etc.). For the area measurement application in a conservation laboratory the required level of sophistication is not very high, so we were able to use a low-cost system which captures the two-level (black and white) image in six seconds. Slow in computer terms, but more than fast enough for this conservation task. This unit is called COMPUTEREYES™ and is produced by Digital Vision, Inc. of Needham, Massachusetts.

The COMPUTEREYES™ system is supplied with software for controlling its basic operations. This software was completely rewritten for the Folger application, since many of the standard features were not needed while new routines were required to permit entry of the reference area and to calculate the final results. The main program is written in BASIC, with machine language routines for the image digitizing and pixel counting. A menu-driven approach is used to keep the operation as simple as possible, requiring no computer sophistication on the part of the operator.

The complete system consists of a low cost black and white television camera, a camera stand, a computer (Atari 600XL) with disk drive and monitor, the digitizing hardware and software, and associated cables, connectors and switches for operating convenience. A signal splitter and video selector switch allow you to display either the computer program display or the camera image on the monitor. You can use the computer monitor for framing and focusing the image to be digitized. By using low-cost components the cost of the entire system was kept to about $2000. It also meant that a complete stand-alone system was practical, rather than having to add on to the conservation laboratory's IBM system. Not only was the complete systems less expensive than just the add-ons had the job been done with the PC, but the stand-alone capability means that the video digitizer system can be kept permanently with the leaf caster, which is situated in a room apart from the main laboratory.

To measure the area for leaf casting, you must first digitize the matte that will be used to define the final page border. The system at the Folger uses a black background and white cardboard for the matte. The digitized image of the matte alone appears as a black rectangle surrounded by white. The computer counts the number of black pixels and relates that to the known area of the matte. Then you digitize the image of the matte with the page to be treated and count the black pixels again. A simple ratio then converts this count to the needed area measurement.

Some distortion of the image might be expected around the edges of the image. In general, though, the accuracy of the area measurement required for the leaf-casting process is not extremely stringent, and to date there has been no problem at the Folger. You could calibrate the system by digitizing images of shapes of known area and comparing the computed to the known area.

Once the area has been calculated the program asks for the thickness of the paper, which the conservator measures with a micrometer and keys in. With this information, the computer calculates the volume of paper to be created. The slurry concentration is also stored in the system, so the computer can also calculate the volume of slurry to be added to the leaf caster. At the Folger pulp slurry is made up to a known concentration, defined in terms of the thousandths of an inch of thickness that will be deposited in each square centimeter of area, per milliliter of slurry. The program output is set up to tell the operator how many milliliters of slurry to add to the leaf caster.

Many of the steps in the program are only required at the beginning of each session with the system. The operator must adjust the camera brightness control so that the paper areas appear light and dark and key in the reference area and slurry concentration. If you are going to cast many pages of the same size, as with a book, you will only need to digitize the reference area one time. As long as the camera height is not changed, the total area in the camera image will remain the same. In practice then, the major part of a digitizing session consists of alternating between only two portions of the complete program - digitizing the image of the page to be treated, and performing the calculation of the amount of slurry to be added. At the Folger, once the operator has set up the system it takes only fifteen seconds per page for the entire process.

SUMMARY

The video digitizer system to assist in leaf casting was installed at the Folger Shakespeare Library in October 1985 and has been in regular use ever since, eliminating many hours of tedious work. The overall quality of the leaf casting operations in the conservation laboratory has improved and is more consistent than before.