Peripheral portrait photography with improvised digital strip camera

Andrew Davidhazy
Peripheral Portrait Photography with Improvised Digital Strip Camera.

Andrew Davidhazy
Imaging and Photographic Technology Department
School of Photographic Arts and Sciences
Rochester Institute of Technology

Strip photography is a little acknowledged yet quite pervasive application of photography used for the purpose of such widely disparate applications as horse race photofinish photography, ballistic-synchro photography and even panoramic photography that encompasses views including 360 degrees around a camera.

Early on in archeological research at the British Museum, sometime in the late 1800's, it had already been determined that one could make 360 degree "roll out" or peripheral photographs of the designs drawn on Greek vases and urns by the simple expedient of rotating the object in front of a camera while continuously moving film past a narrow slot onto which the moving features of the vases's surface were projected by a lens.

It remained for other photographers to reverse this scheme and make the camera rotate during the process, instead of the subject, to make uninterrupted 360 degree panoramic photographs of surrounding landscape. The Cirkut camera, manufactured by Eastman Kodak from the early 1900's till the mid 1940's or so is a typical example of such a camera. There are some modern panoramic cameras based on this system such as the Roundshot, the Globuscope and the Hulcherama.

Finally, the method was also put to good use, starting in the mid-1930s at racetracks to determine, indisputably, the order of finish of race horses reaching the finish line in a close race - making a "photofinish" photograph.

My own experiments in this area of photography, sometimes called "strip" or "smear" photography, date back to the mid-1960's when, spurred on by the work of George Silk of Life magazine, I made my own version of a strip camera by installing a mask in the focal plane of a standard 35mm camera, leaving a narrow, open, vertical slot located just in front of the film plane of the camera. After advancing a full roll of film forward into the take up chamber, all the while keeping the lenscap over the lens, I would then set the shutter on "B", lock it open, remove the lens cap, depress the rewind button on the camera and then start rewinding the film.

As the film passed by the open slot it would be sequentially exposed to whatever image information was thrown onto it by the lens. This could be the image of a subject rotating in front of the camera, a scene moving past the camera by virtue of the camera rotating or a subject passing in front of the lens such as in a photofinish situation.

George Silk (and these days Neil Leifer) had pretty much concentrated on the field of sports photography with superb shots of athletes in action. I myself became particularly interested in peripheral portrait or figure photography.
At first I had models rotate in front of the camera by themselves but they could not remain consistently in place and would often drift off the slot within the camera. Soon enough I had them rotating on a people-bearing-turntable I built but at speeds that would cause them to get nauseous on short order. Eventually I made a turntable from an old record cutting machine that would turn even the heaviest of subjects at a steady and bearable rate of one rotation in 10 seconds.

For many years I photographed a large number of subjects with this improvised 35mm strip camera system. Later, as digital imaging technology became a reality I soon saw a direct connection between the linear CCD arrays and the slit of my strip camera. The only difference between the systems was the fact that film was acting as the memory in one case while memory chips performed the task of remembering what happened at the slit over time in the electronic versions.

For many years I longed to have access to a CCD chip made up of just a single row of photosensitive devices, a linear CCD array. Unfortunately these were usually much too expensive for me to acquire yet I could see a number of applications that the manufacturers of CCD imaging cameras were ignoring because they were "thinking traditionally" when it came to designing photographic applications for their CCD devices.

Well, finally I realized my dream of making my own affordable digital strip camera when I came across a common "hand document scanner". The basis for what was to become my improvised camera was a fairly inexpensive KYE hand document scanner. The device cost less than $50 but it did need a computer to hook it up to. In my case I already had a PC running Windows 95 which is exactly what the scanner needed to perform its function.

It did not take me long to decide to buy one and it was not long after I got it that it was reduced to its basic components and soon thereafter was doing things its designers probably never foresaw as possibilities.

Basically this scanner is a device that can be rolled over flat originals and as it is moved it sequentially but continuously captures whatever passes underneath the scanning head.

The scanner is hooked up to a PC by way of a high speed data transfer card and it is designed to make scans that cover an area of up to 4 inches wide by about 14 inches in length.

As the scanner is rolled over the subject its image essentially moves past a CCD array consisting of many light sensors arranged in line fashion. These detect and record changing image information from the subject that appears to move past the array since the image of the subject is focused on the CCD by a lens focused on the print surface.

The CCD array is filtered in such a manner that it simultaneously records red, green and blue information for a full color reproduction of the original.
After making a few scans of prints to familiarize myself with its operation, I decided to take a peek at the "guts" of the system and looked for the screws that fastened the top to the bottom of the scanner case. They were not difficult to find and soon the two were parted.

It turns out the cover was not really needed to run the scanner and after proving this I proceeded to identify the location of the CCD array. This was easily accessible and it was located at the end of a plastic "funnel" assembly equipped with a deflecting mirror in the chamber. In the middle of the funnel was a lens, the function of which was to reduce the image of the subject's width to the length of the CCD array. The use of a "folded" design made for a nice, low-profile, instrument.

I tried to make images by simply "panning" around my room with the scanner while it completed a scan cycle and I got some fuzzy but recognizable images of my lamp and chairs, the outside parking lot, etc. Promising!

Anyway, the CCD array was connected to the rest of the instrument by way of a multi pin connector. I unplugged this and then removed two screws that held the CCD array in place. The array could be cleanly removed from the imaging funnel and the lens was now easily visible within it.

The next thing was to try to see if the scanner would work with the sensor removed. It did. In fact, I also unplugged the connection to the fluorescent tube and the scanner worked without it also! The only thing it could not do was to complete a calibration process but this did not prevent the software from allowing the scanner to run through a scanning cycle.

At first glance the CCD array looked to be about 20mm long and encased in a glass enclosure about 40mm long, and the whole device attached to a copper clad PC board which in turn had the connecting socket leading to the rest of the scanner attached to it.

Now I taped the scanner's CCD array to the back of an old Canon Ftb camera whose shutter I had locked in the open or B position. The scanner still worked but this time the images recorded were a bit sharper and more recognizable than when I was simply "waving the scanner about"!

The major problem was that the connecting wires of the scanner were much too short to work conveniently with the camera. So I made an "extension" from some multi-wire cable that I had lying around. I essentially added a female "D" socket near the CCD array and at the end of a multi-wire cable soldered to the connections on the PC board I attached a male "D" connector. This way the CCD array could be hooked up to the scanner or mot, to facilitate transportation.

While that "taped" version of the system demonstrated the soundness of the improvisation, eventually I decided to make the system a little more permanent and dedicated an old Minolta camera body to the purpose. I filed out the focal frame of the
camera to the extent that the PC board on which the CCD array was built could be attached to the body in such a manner that the CCD array was approximately in the same location as the film would be in the focal plane of the camera. Since I installed the CCD array along the long dimension of the focal plane, the mirror mechanism of the camera was undisturbed and could still be used to focus the camera lens. A mark was drawn on the groundglass of the camera to indicate where the location of the CCD array would be aimed at once the mirror was lifted up to uncover the CCD array to light from the lens.

Even though the CCD array is epoxied in place, to this date I only have made a fairly temporary installation but that is all that is needed for now. In fact, making the installation permanent would make the array _less_ useful for teaching purposes.

Finally, since the scanner would not be rolling over a surface and the rolling wheels be controlling the rate at which data from the scanner's CCD got transferred to the computer, I took a DC gearhead motor and connected its shaft by way of a rubber band to the shaft of a slotted wheel designed to rotate between a photodetector and an IR light source relaying information to the scanner's software as to the data acquisition rate. Because the scanner itself never was moved, the DC motor therefore provided an artificial rolling rate parameter to the scanner's software which it would use to determine when the scanner had achieved it's preset scanning aspect ratio or dimension.

The data acquisition rate would then control the degree to which a subject appeared to be reproduced normally in terms of aspect ratio or whether it appeared compressed or stretched out in the preliminary record of whatever the scanner was "fed" in terms of input image.

In the case of contact scanning the aspect ratio was always properly maintained but once the advance mechanism was disconnected from the subject itself, as in the case of the decoupling the rolling motion from the scanning action, then the aspect ratio of the reproduction could be altered at will.

So, now I set myself the task of seeing how the improvised scanning digital strip camera would perform in applications similar to those I had been using film based cameras in the past.

The results were astounding. A major problem with film based systems is that the slot can not be made too small due to diffraction effects and also because small changes in the rate at which film is moved past the slot result in slight exposure time changes and these are the "bane" of strip photographers who call the result of such effects as "banding". This is something that is very difficult to overcome with very small slot widths. And small slot widths are needed to arrive at sharp results in cases where the film can not be moved exactly at the same speed as the image of the subject moves.

In peripheral portrait photography, where the subject is made up of many different diameters each resulting in slightly different image velocities at the slot, having to deal
with such changes in image speed are of great concern to the photographer intent on sharp reproductions.

The digital system exhibits few if any of the problems associated with banding and also, due to the small size of the pixels, deals effectively with changes in image velocity by simply showing subjects as having unusual proportions but still retaining sharpness over a wide range of subject image velocities.