Film as the Archival and Entertainment Medium of the 21st Century

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Abstract

ColorCode UnLtd. Corp. brings to the attention of the audience a method for using analog Silver Halide film to become the media of choice for digital archival and entertainment in the 21st Cent. The method uses shades of gray (i.e. colors) to store data in distributed, secure, machine readable, low cost, compressed formats, ideal for Internet uses as will be discussed in the Applications section.

Technology

Let us start with a format we all know and have come to love: barcode.

Many of us are also familiar with 2D codes, which are multirows of short bars. Some other 2D forms are e.g. PDF 417 (™ Symbol Technologies Corp) or OneMatrix (™ RVSI Corp.), which are X-Y coordinate matrices of small rectangular or square cells that are either wholly black or wholly white. Each cell carries 1 bit. ColorCode's hueCode™ technology is 3D and 4D. In 3D each cell is in one of many predefined and distinct shades of gray or Intensity Levels, and can therefore contain several bits per cell. In the 4D application, each cell appears to the naked eye in a hue, which is a superposition of several colors, each in its own shade or Intensity.

This 3D monochrome hueArray™ displays cells whose (1 - Intensity) values are the % of area darkened by the squares and rectangles within it. An alternative effective methodology includes variable thickness of uniformly distributed semitransparent ink or dye. Only the % alteration of the reflected light matters for the cell Intensity value, not the geometry within the cell, nor how this variability is attained.

There exists much variability among recorders of ostensibly same type, reader-scanners ostensibly interchangeable, media ostensibly identical, and results that should be the same but are not. To overcome this problem, our technology embeds several Calibration Cells at known X-Y addresses in each array of cells. The Calibration cells also overcome the problem of fading, if uniform in the small area around each calibration cell.

The calibration cells contain predetermined Intensities and are used by the system to modify the reading results.

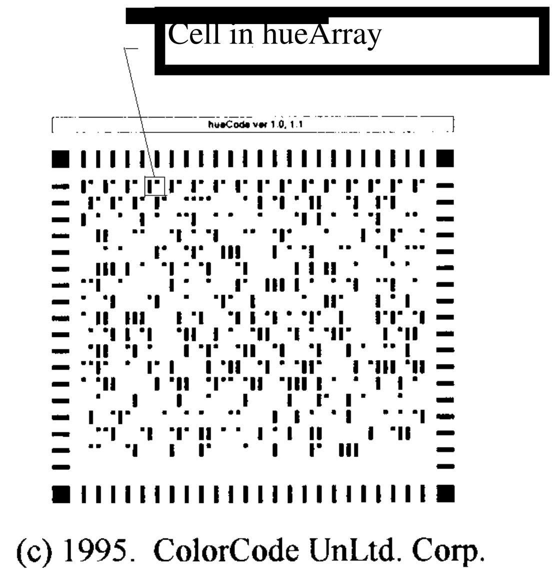

Figure 1: hueArray of simplest type

However, the form of the characterization curve of the medium itself must be known. Also, each recording or reading instrument needs to be repeatable within the area governed by the calibration cells. Since each such cell governs only several dozen data cells, this demand is not onerous.

Obviously one can implement this by printing ink or dye on paper, or exposing duplicating microfilm, or best yet, exposing photofilm. Each will have different Information Densities, depending primarily on the minimum convenient cell dimensions, and the number of Intensities of the monochrome, for the 3D version. For the 4D version the Intensities will be for each wavelength bandpass, and the number of bandpasses superimposable on the same area without causing obscuration.

The bottlenecks for each type of medium are the quality of the medium itself, the Resolution of the Printers or Exposers, and the Resolution of the Reader-Scanners. All three elements need to be considered and the lowest of the three defines the real possibilities for any system.

Opaque media such as Paper and many Plastic films are reflective materials, receiving ink. Assuming the ink or toner is totally opaque, the coverage of area by the ink in each cell determines the Intensity of the light reflected from it. The type of ink or toner or dye also determines the resulting reflected intensity. We could go deeper into this topic, but this paper is not the proper venue. For such ink & dye methods, the cell sizes given today's technology are in the order of 10 cells per linear inch, or .01"x.01" (250 micron x 250 micron), limited by the media. Given better media, this could go down today to 100µ x 100µ. The practical number of distinct intensities per cell today is 16, generating 4 bits per cell. Given the potential of dye sublimation as well as the untapped potential of toner based printing, the number of bits per cell could rise to 6 per color. This means a total information density of 150Kbits/in^2 when in three colors. I.e. a business card or label could contain some 100Kby, and a single sided page some 1.2 Mby. On acid free paper the document could survive for several hundred years.

In contrast, a business card printed with today's laserprinted hueCode technology in the form shown above, contains 3,000 Bytes.

Dupe microfilm is a monochrome device that works by either blocking or not blocking incoming light, therefore in principle works like paper, but in light transmission. Also at much smaller minimum cell sizes, therefore at higher data densities. It also has the advantage that a document can be imaged on it (microfiche), yet its digitized content can be stored in hueCode in the "streets" in between the document images. Therefore it is a good candidate for a true Hybrid storage device.

An even better candidate for both Hybrid and pure digital storage and archival is AgHalide photofilm. Its minimum cell size is limited by film speed and such quality concerns as bubbles in the coating and/or base. I am not privy to the characteristics of spy satellite films, thus cannot tell you the current technological limits of this storage. However, assuming a cell size of .6µ x.6µ, three color bandpasses, and 128 Intensities per color, we get a storage capacity of 500 Gigabits per CD sized disk. This needs to be compared to the current 25 Gigabits per DVD. I.e. 20 times more.

Moreover, the reading of these films can be simple, using only a stationary head and optics, with the film disk rotating.

Eventually, instant film can provide customers the ability to expose disks in a true digital writing fashion.

Of course, these photofilm digital disks would have a 100 year life if refrigerated.

When stored on reels for archival purposes, the Volumetric Information density becomes interesting: assuming .7 area storage efficiency factor, and .003" thick film (75µ), we get about 540 Mbits/cumm or 8 Tbit/cuin. Considering a 160 mm diameter reel of 35 mm film, this means an archival of 350 Terabits/reel.

Considering that even a fast computer takes time to digest the content of a film frame, a fast reel indexer can keep up with most any computer access speed in practise. This ia true if this Storage depends on banks of disks. This makes so called sequential access on reels, practically as fast as random access on stacks of disks.

Another factor needs be considered. Today, when information needs to be stored in direct visual form, this is done on film. When it needs to be stored digitally, this is done on magnetic disks in jukeboxes (the COLD system). In other words, two totally different technologies, needing to be housed separately, sometimes miles apart.

Using photofilm with hueCode digital storage, both human and machine readable forms are archived on the selfsame medium. In other words: instant backup by two versions of the data on the same apparatus.

I will leave it to the audience to consider whether a long lived archival capacity of this nature makes business sense.

For Internet applications, stay warm, we'll get to it shortly.

Applications: What use all this?

In common with all known digital storage methods in field and in labs, the Patented technique processes all knowledge bases: text, data, images, sound, even olfactory and tactile signals when these are transduced to digital data.

We believe photofilm storage/retrieval costs can be lower than any existing or proposed alternative, including 3D cube based storage.

One expanded usefulness is that film not only stores the data digitally, but also imagely, generating a true HYBRID technology capturing images and sound both in their original analog form, with also their contents in the proposed digital form, all within one "Digi-Log" frame.

The Digi-Log film can be negatives, since the software can perform image positivization.

The original information is captured or created by any available means (digital camera, scanner, program, etc). The information is then encoded using algorithms and converted to a special image consisting of arrays of cells (hueCells™). Upon retrieval, decoding algorithms retranslate the information into human comprehensible form. The information can be distributed in the compact forms over the Internet for very rapid information transfer, whilst the decoding can then occur locally.

Internet Applications:

One way for movie, video, and music makers to make money over the 'Net, is to charge for downloading files greater than a certain length in each category. Another is to have two types of broadcasts: one of low price for one-time viewing that includes advertisements on the periphery of the picture, and another at higher price without the ads, for recording.

However, another way is to transmit the information in encrypted hueCode, for a local software program to translate the images and sound into human friendly forms. This program could be rented or leased or given free, with the payment being per download and with the necessary decrypting keys.

Moreover, these videos, however transmitted, may be recorded in a manner akin to hard but removable storage at people's homes. Recordable DVDs are one way of doing this, but hueCoded photofilm is a much better way, since it stores so much more data. Obviously this requires appropriate Instant photofilm, but I suspect this is not a problem.

Another element in the hueCode-on-film appeal is the upcoming Interactive Videos: the customer having the option of determining the course of the video story. As there will be many options, few end results will be similar, even if originating from the same title. All this will motivate people to record Their Version to show others and future re-view.

In Summary

The 3D and 4D hueCodes™ are the next levels up from 2D and barcode. In 3D and 4D the information can be stored at many levels of area & volumetric density (By/in^2 & By/in^3) on a variety of media, including film, paper, metal foil, photopaper, etc. Indeed the first implementation of the technique was achieved onto plain paper. However, large databases need be stored preferentially on film or microfilm.

The methodology hinges on the accuracy of solid state technology in detecting properties of light in selected bandpasses. Built-in is a mathematical signal intensity calibration technique compensating for distortions due to recorder, reader, media and eventual fading.

This technology offers the archival and entertainment and Internet industries many formats including planar disk, reel-to-reel, cards, and others to achieve widespread, highly compact, multi-media, distributed information playing, recording, archival, unerasable storage, Internet and Entertainment uses, and more.

ColorCode is seeking Strategic Partners with whom to develop the technology and first application markets.