RGB LASER system for direct recording of digital image data on colour microfilm for long-term preservation

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An RGB laser system - the Eternity - has been developed to provide direct high-speed recording of digital (image) data on colour microfilm. The Eternity is based on red, green and blue lasers at its core writing colour images with an ultimate resolution of 7,580 dpi. These authentic colour microfilm copies enable safe and economic long-term preservation of digital images and colour documents.

Introduction

Part of the huge amount of digital data generated every day has to be preserved for decades due to legal reasons or even for centuries for future generations. Because the readability and lifetime of electronic storage media is endangered due to technical obsolescence (the digital cliff), electronic digital storage systems have to be reformatted and/or copied onto new media every five to ten years. Consequently, digital data retention and archival storage lead to high recurring costs combined with security and safety constrains [1-3].

Motivation: data preservation beyond digital storage

In contrast, microfilm has a life expectancy of several hundred years and its content and format is always readable, hence, microfilm is a safe and migration-free archival medium. While b&w microfilm is well established for long-term preservation, colour microfilm has been limited due to the lack of high-quality, productive and easy-to-use equipment.

Solution: RGB laser COM

An RGB laser COM (computer output microfilm) device - the Eternity - has been developed by Pro Archive to provide users a unique device for high-resolution and high-speed recording of digital image data on colour microfilm [4]. Thanks to its ultimate resolution of 7,580 dpi one colour microfiche (A6 postcard format) stores 3.65 GB of digital image data or about 100 original A4 colour pages. A 60 m microfilm cassette allows recording of 400 microfiches without reload, hence enabling autonomous recording of about 40,000 A4 colour pages within 48 hours of operation.

Technology

The Eternity 105 is the first RGB laser COM system for direct recording of digital data on 105 mm colour microfilm. The Eternity's basic concept is shown in Fig. 1.

The red, green and blue laser beams are modulated according to the incident bit stream of the image data using three acousto-optic modulators. Then the beams are coupled into an optical fibre for flexible delivery to the scanning head where the combined beam is focused to a pixel size of 3.3 μm (FWHM).

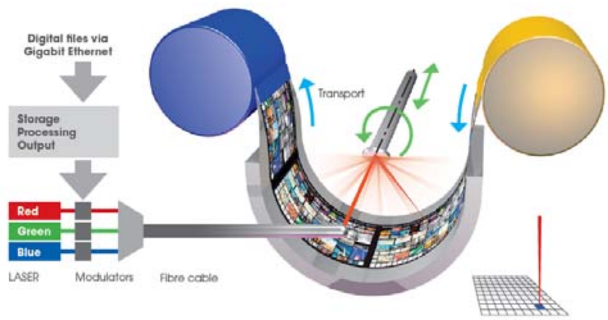

Fig. 1 *Eternity's technology is based on RGB lasers, acousto-optic modulators, fibre optical beam delivery, and an air-bearing scan head in an internal drum.*

The scanning head is rotating at 6,000 rpm while recording pixel by pixel of the image data onto the microfilm which is hold in the drum by vacuum. A piezo-driven linear axis ensures ultra-precise line by line movement of the scanning head.

In the internal drum configuration, the focused RGB laser beam hits the film material in normal incidence at any position over the exposure area. This ensures high resolution and consistent colour quality without the well-known compromising effects of classical camera- and display-based photographic exposure systems. The drum configuration of the Eternity also provides the freedom of recording on different film widths, such as 35 mm, 70 mm, 105 mm or even 240 mm.

The high-tech air-bearing scanning system with its submicron resolution providing an ultimate 7,580 dpi is a unique feature of the Eternity device.

Based on its innovative concept and its optimized colour calibration algorithm, the Eternity is able to produce true colour and greyscale images, finest details and high contrast with a superior productivity. Data can be recorded as analogue image and/or digital code. The solid engineering and robust construction of the Eternity is based on proven components from lithography and metrology systems.

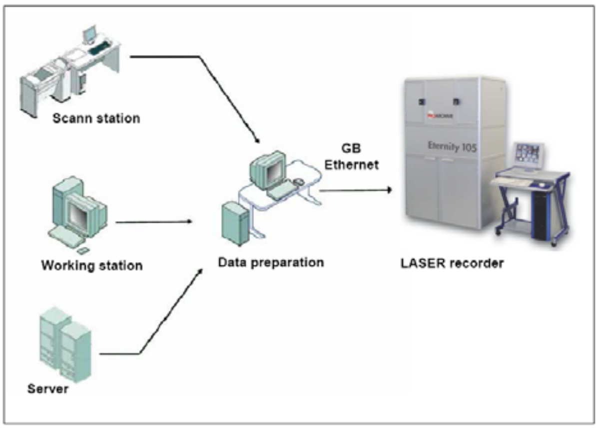

***Fig. 2** The Eternity RGB laser COM system is connected to a local network via GB-Ethernet.*

The Eternity is connected to the customer's local network via GB-Ethernet which ensures high enough data rate to feed the Eternity with a stream of image files for recording (Fig. 2). The Eternity provides an unsurpassed productivity of 12 colour microfiches per hour corresponding to about 1 TB of image data per 24 hours.

The future: preservation of audio data on microfilm

Writing human readable data or image files to microfilm is straightforward. Converting binary data into images allows microfilm to hold binary data (as illustrated in Fig. 3). The binary microfilm must include unambiguous decoding instructions (e.g. human-readable text) so that the data can be scanned and retrieved in the future [5, 6].

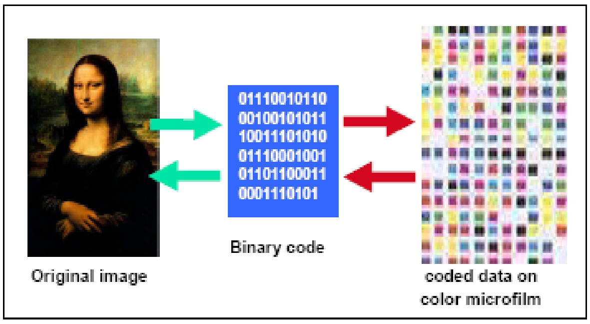

***Fig. 3** Laser microfilm can be used as a coded optical preservation medium with unbeatable longevity.*

By adhering to these guidelines, digital obsolescence can be overcome and color microfilm becomes a coded optical storage medium for any digital data such as audio, video, 3d CAD, software-codes, encryption-codes, etc. with unbeatable longevity and no need for migration for centuries.

Summary

The Eternity RGB laser COM system offers an excellent solution to preserve digital image data in extremely high resolution and with high colorimetric quality.

Furthermore, laser recording of "bits on film" enables color microfilm to become a coded optical preservation medium for all data formats.

In conclusion, Archives, libraries, museums, publishers and other public and non-public organizations are now provided with an easy to handle high-quality and high-speed recording device which enables them to implement safe and affordable data preservation concepts based on color microfilm for archiving beyond digital.

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Author biography

Daniel Fluck studied physics at the Swiss Federal Institute of Technology (ETH) in Zürich and received a Ph.D. in physics in 1995. He researched as a post-doc at ETH until 1999. He has more than 15 years of R&D experience in the fields of nonlinear optics, optical waveguides and fibres, solid state lasers and laser systems.

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