Micro-Display Vs. Scanning Mirrors Projectors

Two projection mechanisms

Image generation from handheld projectors is possible using two basic projection mechanisms: Micro-Displays and Scanning Mirrors:

- Micro-Displays allow the projection of the whole picture in its entirety (all the picture's elements - pixels). This is the technology principle widely used today in business and leisure (home-theater) projectors.
- Scanning Mirrors allow the projection of images' built-up by a very fast sequential 'flying spot' projection of single pixels. Scanning Mirror systems use laser illumination as light source.

Handheld Projector's Performance

For consumer electronics applications, performance as well as the manufacturing costs, will ultimately determine the success of a technology. Specifically, performance of a miniaturized battery operated personal projector will be measured by:

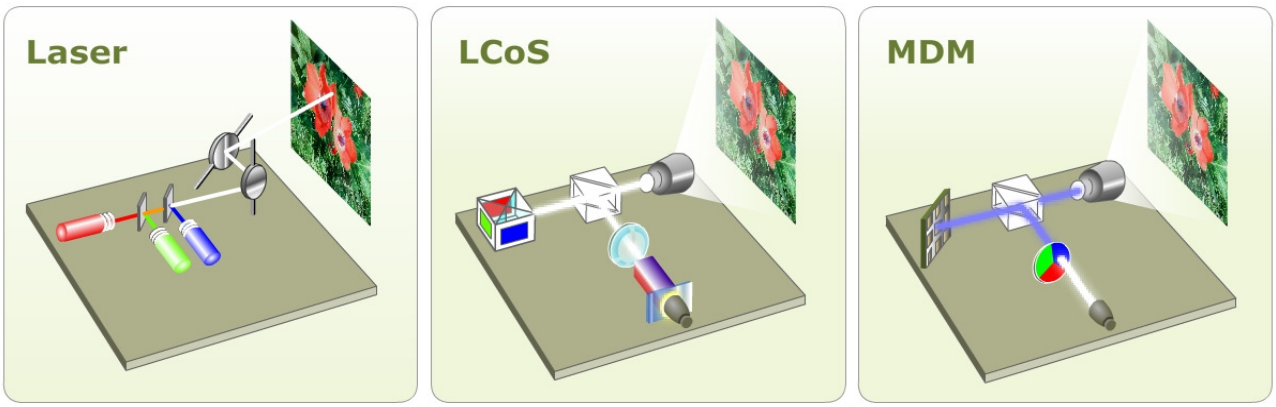
- Power efficiency in terms Lumens per Watt - optical power output (Lumens) per Electrical input power (Watts),
- Size and Form factor,
- Color gamut and Image quality.

Module Miniaturization

Lumens / Watt

The system's overall power efficiency is the product of the efficiencies of the main components along its optical path.

The Micro-Display architecture efficiency is made up of the combined efficiencies of the (a) Micro-Display elements (LCD, LCOS or DLP); (b) Illumination source and; (c) Other optical elements such as a focus lens or a polarizer required for LED based illumination or a diffuser required for laser-based illumination.



Principle Projection Technologies

Scanning Mirrors Efficiency

The efficiency of the Scanning Mirror architecture is based on a smaller number of components: (a) The modulated laser source and; (b) The reflective mirror(s)

mechanism.

Laser projection optics enables a 'focus free' solution thus saving the focus lens mechanism, as well as the polarizer and the diffuser.

Micro-Display Efficiency

An Ultra High Performance Lamp (UHPL) illumination source is unsuitable for miniaturized battery operated personal projector applications due to its power consumption. The Micro-Display could instead be illuminated by LEDs or laser sources.

An LED light source eases the power and heat dissipation constraints, however it needs to be collimated (and also polarized when using LCOS).

The Micro-Display overall efficiency will then be dependent on the efficiency elements of the LED sources, the collimator and the polarizer (when used).

If the Micro-Display uses a laser as its light source – the overall efficiency will be dependent on the laser source and the accompanying diffuser.

The efficiency of the mirror's mechanism reflective coating in the Scanning Mirrors approach is better than the efficiencies of the polarizer or the diffuser in the Micro-Display architecture.

Continuous Illumination

In addition a Micro-Display architecture requires a continuous laser/LED illumination versus a Scanning Mirror system, in which the laser is basically modulated according to the pixel information reducing to a minimum the power consumption.

Superior Efficiency

Therefore, the Scanning Mirror projector architecture results in a higher Lumen per Watt metric regardless of the superior efficiency of the lasers source itself (over UHPL and LEDs).

Miniaturization – Volume and Form Factor

The "power of miniaturization" is another performance benchmark dimension:

The Scanning Mirrors method is basically "uni dimensional" in the sense that the projected combined (RGB) beam spot is a pixel's scale and the projected image is built one pixel at a time. Comparably, the Micro-Display architecture is inherently a planar one - the projection "spot" is scaled by a whole frame of pixels which is synchronously projected.

Module Miniaturization

Micro-Display volume implications

The requirement to increase the Micro-Display resolution is met with the need for more pixels and thus more elements (such as micro-mirrors in a DLP chipset) which results in an increase of the overall planar size. This has an impact on both (vertical and horizontal) dimensions and consequently affects the overall system size.

The resolution achieved by the Micro-Display architecture is therefore related to the overall size of the projection module.

In comparison increasing the resolution of the Scanning Mirrors alternative requires

a marginal increase of the reflective mirror size. The resolution of the Scanning Mirrors architecture therefore has a marginal impact on the projector's size.

Manufacturing Cost

The manufacturing cost is another benchmark for the success of consumer electronics products. The cost depends on: the number of elements involved, the process complexity and scaling and the required accuracy.

Both the Micro-display and the Scanning Mirrors are manufactured based on MEMS (Micro-ElectroMechanical Systems) technology. However while the Micro-Display wafer is based on submicron accuracies, the Scanning Mirrors systems allow a simpler production of bigger sub-elements.

Control circuitry

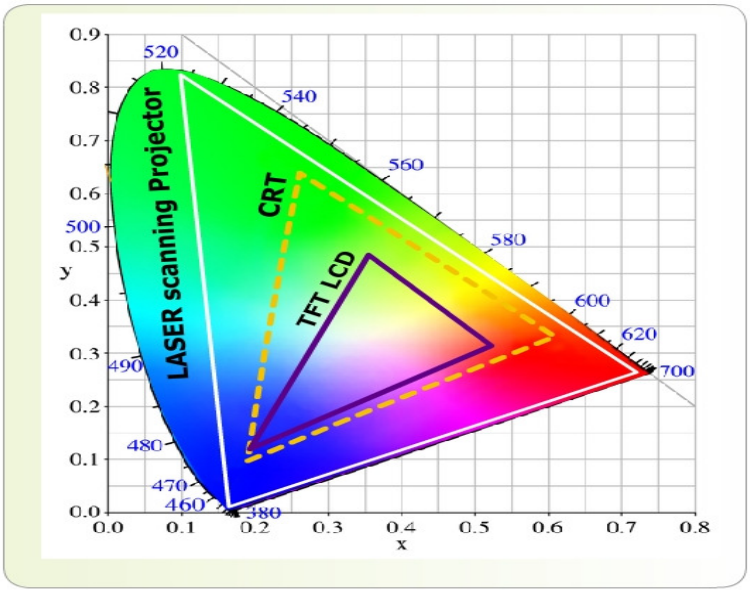
In addition to the costs difference of the optical elements, the control circuitry costs are expected to be higher in the Micro-Display architecture.

Micro-Display control circuitry must process massive amounts of information as it deals with the projection of the whole image frame. The Scanning Mirrors and Laser control circuitry is comparatively much simpler as it monitors only the sequential projection of a single pixel at a time.

Exceptional broad color gamut

Among the other significant quality advantages that laser offers is its known broad exceptional color gamut. Selecting Lasers of the saturated RGB primary colors enables the coverage of over 90% of the Color Model and the human eye viewable spectrum.

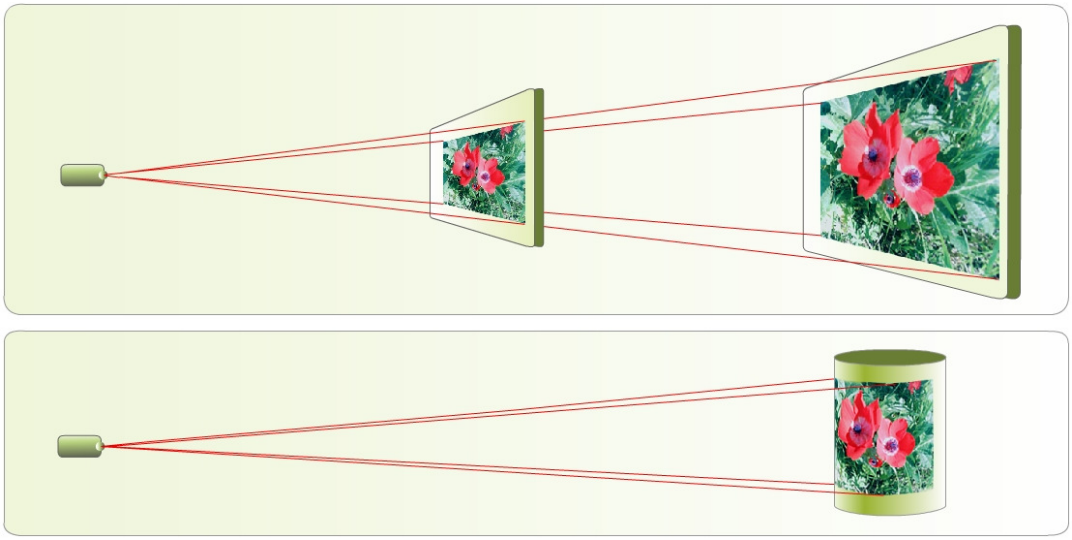
The Color Model below presents the available color gamut per specific display technology; CRT, LCD, Plasma etc (e.g: CRTs are said to have a better color gamut than LCDs – meaning that their projected colors are richer).



Illustrated Color Model

With the increased availability, reduced cost and increase in customer expectation for true colors, it is not surprising that laser technology has begun to be used in the TV industry.

Lasers, as diffraction limited light sources, don't require any focusing element thus preventing the associated optical losses and reducing product size, while producing an image which is always in focus. This quality is particularly relevant for mobile applications, where motion is inherent in the user experience and projection surfaces are inconsistent or even curved.



Always in focus on any surface

Summary

The Scanning Mirrors approach provides system simplicity, enables superior overall optical efficiency, optimal miniaturization, as well as better color gamut, all with lower manufacturing costs.

Scanning Mirrors technology is therefore best suited to drive the promising mass market of miniature personal projector applications.

Current Micro-Display technologies have reached a miniaturization level where next step challenges need to be addressed from a new angle - Scanning Mirrors and Lasers technology provide this leap forward.

Zeppelin has an important role in the birth of aviation, though it is the airplane which had carried us to our times…