1 Overview

Digital Light Processing (DLP®) is known as a multipurpose, robust, modern, and easily accessible optical technology that uses digital micromirror devices (DMDs), which reflect light pixelwise from a light source to a target. DLP® was invented by Texas Instruments and is commonly used in projectors, as shown in Fig. 1, but is also used in other fields.

The internal structure of a DMD is visible in Fig. 2. Many reflective micromirrors are placed in an array. Each micromirror represents an optical pixel (Fig. 3). Depending on the format (there are different formats available) of the DMD, the array has a number of micrometers placed on it, e.g., 768×1024 (XGA) or 1920×1080 (FullHD 1080p).

To protect the micromirrors from external influences, a cover glass is installed on the aperture. The DMD is, in most cases, deliverable as a UV-, VIS-, or IR-optimized version, depending on the field of application.

Figure 1 BENQ DLP® projector. Image courtesy of Sign-Tronic AG.

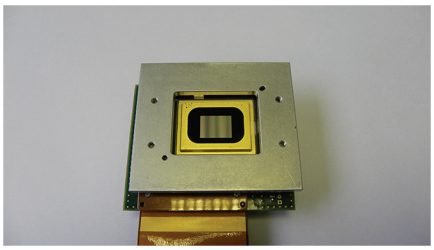

Figure 2 XGA DMD on a mounting plate. Image courtesy of Sign-Tronic AG.

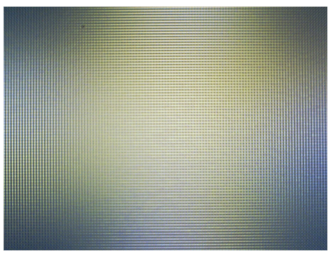

Figure 3 Micromirrors on a XGA DMD 35x magnification. Image courtesy of Sign-Tronic AG.

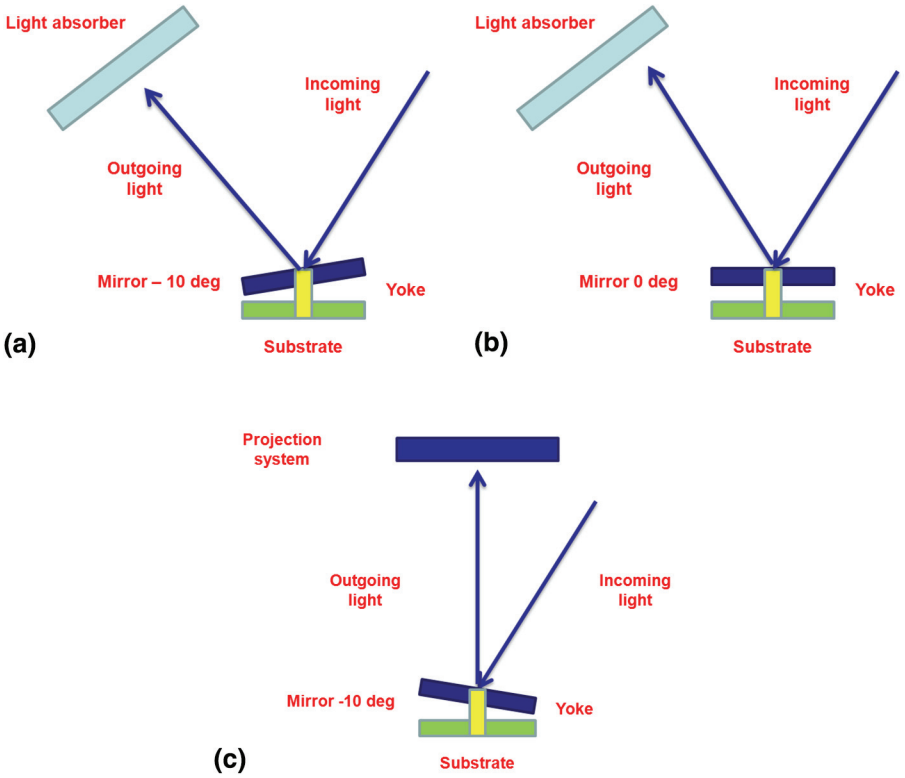

Figure 4 Working principle micromirror. Image courtesy Sign-Tronic AG.

Figure 4 shows the detailed composition of the micromirror attached on a hinge above the CMOS substrate. By electrostatically tilting the mirror in one direction or another, the light is reflected either through the objective or to a black absorbing site inside the optical system (Fig. 5).

The pixel pitch of each micromirror has a value of 13.65 µm for the XGA DMD and 10.8 µm for the FullHD 1080p DMD. The projected pixel pitch on the target relies on the magnification of the objective, where <1 means a reduction and >1 means an enlargement.

Aside from DLP®, the most familiar projector technology includes a liquid crystal display (LCD) and liquid crystal on silicon (LCOS). The disadvantage of these kind of modulation modules is DMD, that they were not specifically developed for applications where UV light is used. There might be a risk, depending on the UV dose, that the modulator is destroyed over the course of time.

A further possibility—currently in the development/launch phase, so there is not much experience to draw on—is a single mirror (Fig. 6) and mLeds. The single mirror actively tilts in two axes and reflects a single laser beam to the target.

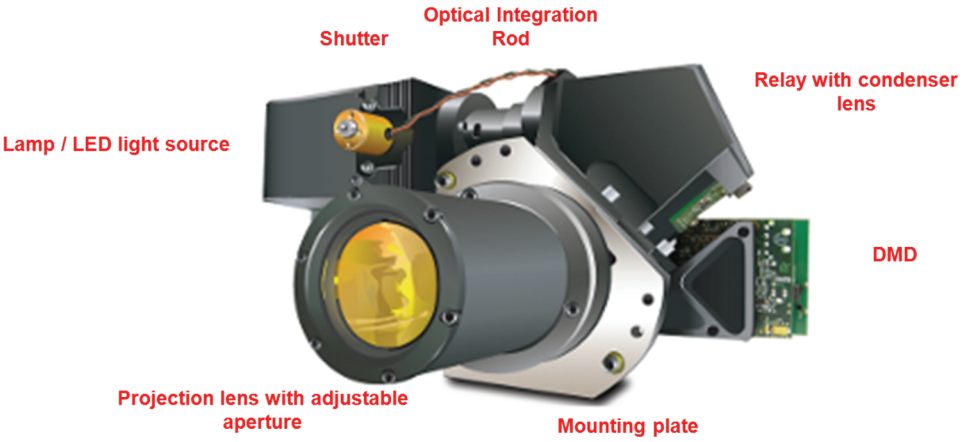

Figure 5 Components of an optical engine. Image courtesy of Sign-Tronic AG.

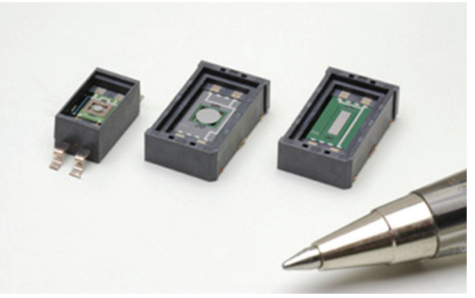

Figure 6 Hamamatsu MEMS mirror. Image courtesy of Hamamatsu Photonics.[1]

An mLed is an array of microlight emitting diodes (LEDs), which can be controlled pixel by pixel.

By evaluating all of these projection technologies, the conclusion is that DLP® technology unites these positive factors:

- Robustness to different wavelengths (UV–VIS–IR) and power levels,
- Well-known and accepted technology on the market,
- Low price and low maintenance/operation costs,
- High-exposure speed with large resolution (depending on the light source and the objective), and
- Broad range of different form factors.

These points are the reasons that DLP® can be used for many fields of application, such as computer lithography, 3-D printing, and spectroscopy.