

## Digital Light Processing

Prof. Rahul R. Ambalkar  
Asst. Prof Dept of EXTC  
MGI-COET,Shegaon,Maharashtra.  
[ambalkar.rahul@gmail.com](mailto:ambalkar.rahul@gmail.com)

Mr. Suraj Datta Ghodge  
EXTC Dept. Final year student.  
MGI-COET,Shegaon,Maharashtra.  
[surajghodge1994@gmail.com](mailto:surajghodge1994@gmail.com)

Miss. Alka Prakash Morey  
EXTC Dept.final year student  
MGI-COET,Shegaon,Maharashtra.  
[alkamorey1@gmail.com](mailto:alkamorey1@gmail.com)

**Abstract**—Digital lightweight process may be a show technology developed by Texas instruments. a knowledge projection technology from TI that produces clear, clear pictures on screens in lit rooms. DLP is employed altogether styles of projection devices, from knowledge projectors that weigh solely a couple of pounds to massive rear-projection TVs to electronic cinema projectors for flick theaters. The technology uses a spatial lightweight modulator known as a "Digital small mirror Device" (DMD). The doctorate may be a microchip lined with hinged, microscopic mechanical device mirrors, one for every element on the screen. For instance, a 1280x1024 resolution uses over 1,000,000 "micromirrors" that tilt ten degrees forward or backward, acting as lightweight switches. Every mirror is sixteen micrometers sq., and every one of them matches on a CMOS chip the dimensions of an item.

**Keywords:** *Digital lightweight process DLP, DigitalMicromirrorDevice doctorate, small electro mechanical systems MEMS.*

\*\*\*\*\*

### I. DMD

DLP suggests that digital lightweight process and its supported small electro system device called the digital small mirror device (DMD). The doctor's degree micro chip is that the quick, reflective digital lightweight switch. It are often combined with image process, memory, a light-weight supply, and optics to make a DLP system capable of protruding massive, bright, seamless high distinction color pictures with higher color fidelity and consistency than current displays. Digital lightweight process could be a technology likewise as video projector. It absolutely was fancied in Texas instrument in 1987 by Dr. Larry Hornbeck, that creates the ultimate wish to show digital visual data. Large-screen, high-brightness electronic projection displays serve four broad areas of application: (1) Electronic shows e.g., business, education, advertising (2) recreation (e.g., theatre, sports bars, theme parks, electronic cinema), (3) standing and knowledge (e.g., military, utilities, transportation, public, sports) and (4) simulation (e.g., training, games). The electronic presentation market is being driven by the generality of software package that has place subtle presentation techniques (including multimedia) into the hands of the common computer user. Digital lightweight process is that the one amongst primary show technologies driving this ascent and maturation. It's a revolutionary thanks to project and show data supported the Digital small Mirror Device (DMD) Digital lightweight process creates deeper blacks, conveys fast paced pictures all right and uses one, standardized, white -light bulb. It is on the market in each front-and rear-projection models DLP is a wonderful selection for those who watch lots of sports or fast-action movies attributable to the speed



Fig: DMD Chip

DMD stands for digital micromirror device. It's associate degree optical semiconductor chip that's core DLP projection technology. Doctorate chip was fancied by Dr.Larry Hornbeck and Dr. William E. "Ed" Viscount Nelson of Texas instrument in 1987

ADMD chip consists of many hundred thousand microscopic mirrors organized during a rectangular array that correspond to the constituent within the image to be displayed. The mirror in doctorate chip may be tilts  $\pm 10-12^\circ$ , to associate degree ON or OFF state. Within the ON state light-weight from the projector bulb is mirrored into the lens creating the constituent seem bright on the screen within the off state the sunshine is directed elsewhere, creating the constituent seem dark. to come up with grayscales ,the mirror is toggle ON and OFF in in no time manner and shade manufacture is confirm by the magnitude relation of on time and off time .coeval doctorate chip may be manufacture up to 1024 reminder grey. The mirror area unit created out of aluminum and area unit around sixteen micrometers across each mirror is mounted on yoke that successively is connected to support posts by criticism torsion hinges. In

form of hinge the axel is fastened at each finish and twist within the middle

The position of mirror is control by electricity attraction. Every combine has one conductor on all sides of hinge, with one in every of the combine positioned to act on all sides of the yoke and also the different acting directly on the mirror. Digital small mirror device is associate degree optical semiconductor that's the core of DLP projection technology. The word optical deals with light-weight.

The original read of DLP chip is shown in higher than figure one.0. Within the little chip of doctorate has many hundred thousand microscopic mirror organized during a rectangular array that correspond to the pixels within the image to be displayed. The mirror scan is one by one turned  $\pm 10-12^\circ$ , to associate degree on or off state. Within the on state, light-weight from the projector bulb is mirrored into the lens creating the constituent seem bright on the screen. Within the off state, the sunshine is directed elsewhere, creating the constituent seem dark. To come up with grey scales, the mirror is toggled on and off terribly quickly, and also the magnitude relation of on time to off time determines the shade made. Modern doctorate chips will manufacture up to 1024 reminder grey. We grasp that in doctorate mirror is act as switch and people array of switches area unit created from aluminum and around sixteen micrometers across. Everyone is mounted on a yoke that successively is connected to 2 support posts by compliant torsion hinges. During this form of hinge, the shaft is fastened at each ends and virtually twists within the middle. Tests have conjointly shown that the hinges cannot be broken by traditional shock and vibration, since it's absorbed by the doctorate super structure.

Two pairs of electrodes management the position of the mirror by electricity attraction. Every combine has one conductor on all sides of the hinge, with one in every of the pairs positioned to act on the yoke and also the different acting directly on the mirror.

Architecture of DMD:

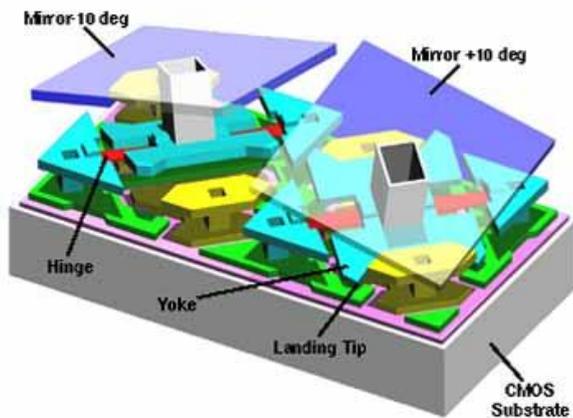


Fig. Architecture of DMD

The Address Sequence

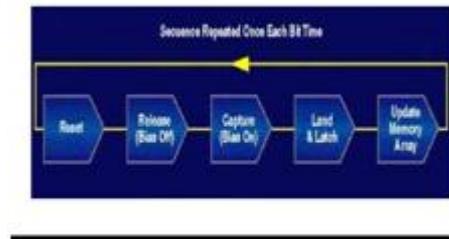


Fig: Address and Reset sequence

The two metal mirrors are shown .It is fixed on C MOS Substrate with the help of yoke loading tip, hinge. The mirror are going to be ON or OFF by tilting mirror +10 or -10 degree with the help of electronic charges hold on in C MOS CELL. The Doctor of medicine is monolithically made-up by CMOS-like processes over a CMOS memory. Each light-weight switch has Associate in nursing metal mirror, sixteen um sq., which is able to mirror light-weight in one in all a pair of directions, betting on the state of the underlying memory cell. Rotation of the mirror is accomplished through static attraction created by voltage variations developed between the mirror and so the underlying memory cell. With the memory cell among the on (1) state, the mirror rotates to +10 degrees. With the memory cell among the off (0) state, the mirror rotates to -10 degrees. The address circuit and computer structure of each constituent support one simple operate, the short Associate in Nursing precise rotation of associate degree metal little mirror, sixteen micrometer sq., through angles of +10 and -10 degrees. Figure illustrates the planning of one constituent. Once the mirror rotates to its on state (+10 degrees), light-weight from a projection provide is directed into the pupil of a projection lens and so the constituent appears bright on a silver screen.

When the mirror rotates to its off state (-10 degrees), light-weight is directed out of the pupil of the projection lens and so the constituent appears dark. Thus, the optical shift operate is exclusively the speedy guiding of sunshine into or out of the pupil of the projection lens.

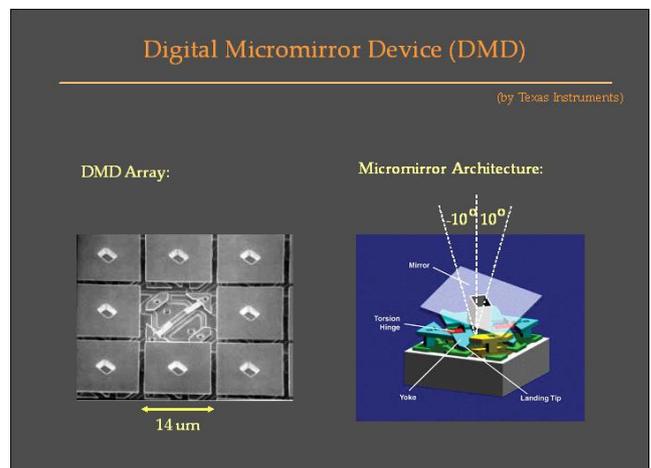


Fig: Broken chip of DLP

Fig 4 shows that the mirrors are creating transition from ON to OFF or contrariwise. This ON or OFF state of mirror is depends on the worth store in memory cell. The state of the SRAM cell (1, 0) determines that mirror rotation angle is chosen. As a result of arithmetic determines the rotation angle, as opposition a balance of static torques as in earlier TI devices, the rotation angle of +10 or -10 degrees is exactly determined. The Doctor of medication constituent is additionally a monolithically integrated MEMS structure cell made-up over a CMOS SRAM cell. Air gaps are in between the metal layers of the structure. The air gaps free the structure to rotate concerning a combine of compliant torsion hinges. The mirror is connected to Associate in nursing underlying yoke that successively is suspended by a combine of thin torsion hinges to support posts. The yoke is electrostatically interested by the underlying yoke address electrodes. The mirror is electrostatically interested by mirror address electrodes. The mirror and yoke rotate till the yoke involves rest against mechanical stops that are at a uniform potential as a results of the yoke. The position of the mechanical stops limits the mirror rotation angle to +10 or -10 degrees. The address electrodes for the mirror and yoke are connected to the complementary sides of the at a lower place lying SRAM cell. The yoke and mirror are connected to a bias bus made-up at the Metal- three layers. The Doctor of medication mirrors are sixteen micrometer sq.They're clothed to form a matrix for optimum use of sunshine.

The academic degree accepts electrical words representing gray levels of brightness at its input and outputs optical words. The sunshine modulation or amendment technique is termed binary pulse dimension modulation. Associate 8-bit word is input to each digital light-weight switch of the academic degree yielding a attainable of twenty eight or 256 gray levels.

The address sequence to be performed once as time is summarized as follows:

1. Reset all mirrors inside the array.
2. Stop working bias to allow mirrors to begin to rotate to flat state.
3. Flip bias on to change mirrors to rotate to addressed states (+10/-10 degrees).
4. Keep bias on to latch mirrors (they will not answer new address states).
5. Address SRAM arrays at a lower place the mirrors, one line at a time.
6. Repeat sequence beginning at the first step.

## II. GRAYSCALE AND color OPERATION

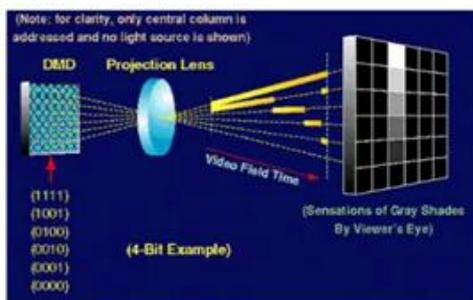


Fig Grayscale andcolor Operation

Firstly we are going to see what's grayscale the grey scale is outlined as grey scale could be a very of reminder gray while not apparent color. The darkest attainable shade is black, that is that the total absence of transmitted or mirrored light-weight. The lightest attainable shade is white, the overall transmission or reflection of sunshine in the least visible wavelength s. Intermediate reminder grey area unit portrayed by equal brightness levels of the 3 primary colors (red, inexperienced and blue) for transmitted light-weight, (or equal amounts of the 3 primary pigments (cyan, magenta and yellow) for mirrored light-weight. Within the case of transmitted light-weight (for example, the image on a pc display), the brightness levels of the red (R), inexperienced (G) and blue (B) parts area unit every portrayed as variety from decimal zero to 255, or binary 00000000 to 11111111. For each constituent in a very red-green-blue (RGB) grey scale image  $R = G = B$ . The lightness of the grey is directly proportional to the quantity representing the brightness levels of the first colors. Black is portrayed by  $R = G = B = \text{zero}$  or  $R = G = B = 00000000$ , and white is portrayed by  $R = G = B = 255$  or  $R = G = B = 11111111$ . As a result of their area unit eight bit s within the binary illustration of the grey level, this imaging technique is termed 8-bit grey scale.

Within the case of mirrored light-weight (for example, in a very written image), the degree of cyan (C), magenta (M), and yellow (Y) for every constituent area unit portrayed as a share from zero to a hundred. For every constituent in a very cyan-magenta-yellow (CMY) grayscale image, all 3 primary Pigments area unit gift in equal amounts.

The lightness of the grey is reciprocally proportional to the quantity representing the amounts of every pigment.

In some systems that use the RGB color model, there are a unit a pair of sixteen or sixty five,636, attainable levels for every primary color. once  $R = G = B$  during this system, the image is thought as 16-bit grayscale as a result of the decimal variety sixty five,536 is appreciate the 16-digit binary variety 1111111111111111. Like 8-bit grayscale, the lightness of the grey is directly proportional to the quantity representing the brightness levels of the first colors. Together may expect, a 16-bit digital grayscale image consumes much more memory or storage than a similar image, with a similar physical dimensions, rendered in 8-bit digital grayscale. Grayscale is achieved by binary pulse dimension modulation of the incident light-weight. Color is achieved by victimization color filters, either stationary or rotating, together with one, two, or 3 doctorate chips. The doctorate light-weight switch is ready to show light-weight on and off apace by the beam-steering action of the mirror. Because the mirror rotates, it either reflects light-weight into or out of the pupil of the projection lens, to form a burst of digital light-weight pulses that the attention interprets as associate analog image. The optical switch time for the doctorate light-weight switch is  $\sim 2$  United States of America.

The technique for manufacturing the feeling of grayscale to the observer's eye is termed binary pulse dimension modulation. The doctorate accepts electrical

words representing grey levels of brightness at its input and outputs optical words, that area unit taken by the attention of the observer as analog brightness levels. The small print of the binary pulse dimension modulation (PWM) technique area unit illustrated in Figure. For simplicity, the PWM technique is illustrated for a four-bit word (2<sup>4</sup> or sixteen grey levels). Every bit within the word represents time length for light-weight to air or off (1 or 0). The time durations have relative values of twenty, 21, 22, 23, or 1, 2, 4, 8. The shortest interval (1) is termed the smallest amount important bit (LSB). The longest interval (8) is termed the foremost important bit (MSB). The video field time is split into four time durations of 1/15, 2/15, 4/15, and 8/15 of the video field time. The attainable grey levels made by all mixtures of bits within the 4-bit word area unit twenty four or sixteen equally spaced grey levels (0, 1/15, 2/15 . . . 15/15). Current DLP systems area unit either 24-bit color (8 bits or 256 grey levels per primary color) or 30-bit color (10 bits or 1024 grey levels per primary color).

### III. ELECTRONIC OPERATION

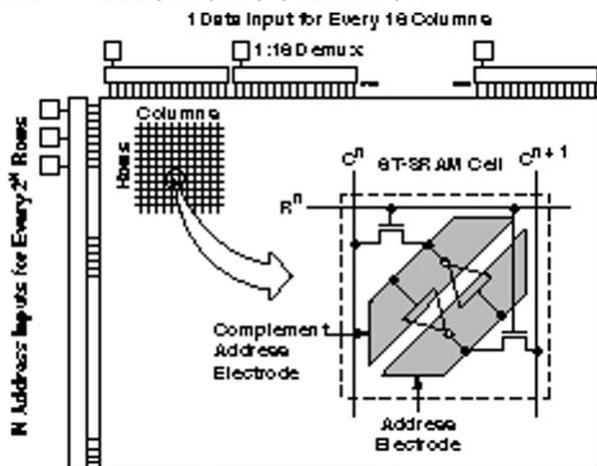


Fig –Organization of DMD chip

The DMD constituent is inherently digital thanks to the manner it's electronically driven. It's operated in an electrostatically bistable mode by the application of a bias voltage to the mirror to attenuate the address voltage necessities. Thus, massive rotation angles will be achieved with a standard 5-volt CMOS address circuit. The organization of the DMD chip is shown in Figure ten. Underlying every DMD mirror and mechanical structure cell could be a six-transistor SRAM. Multiple knowledge inputs and demultiplexers (1:16) area unit provided to match the frequency capability of the on-chip CMOS with the specified video knowledge rates. The heart beat dimension modulation theme for the DMD needs that the video field time be divided into binary time intervals or bit times. Throughout every bit time, whereas the mirrors of the array area unit modulating light-weight, the underlying memory array is reinvigorated or updated for consecutive bit time. Once the memory array has been updated, all the mirrors within the array area unit discharged at the same time and allowed to maneuver to their new address states. This coinciding update of all mirrors, once in addition to the PWM bit-splitting algorithmic rule, produces an inherently low-flicker show. Flicker is that the visual whole

thing which will be made in CRTs as a result of brightness decay with time of the phosphor. Correct operation of the DMD is achieved by victimization the bias and address sequence is elaborated as

1. Memory ready: all the memory cells beneath the DMD are loaded with the new address for the mirrors.
2. Reset: all mirrors area unit set in parallel (voltage pulse is applied)
3. Unlatch: the bias is turned off to unlatch mirrors and permit them to unleash and start to rotate to flat state.
4. Differentiate: retarding fields area unit applied to the yoke and mirrors so as to rotationally separate the mirrors that stay within the same state from those who area unit to cross over to a brand new state

### IV. THREE CHIP PROJECTOR

A three-chip DLP projector uses a prism to split light from the lamp, and each primary color of light is then routed to its own DLP chip, then recombined and routed out through the lens. Three chip systems are found in higher-end home theatre, projectors large venue projectors and DLP Cinema projection systems found in digital movie theatres. The three chip projectors used in movie theatres can produce 35 trillion colors, which many suggest is more than the human eye can detect. The human eye is suggested to be able to detect around 16 million colors, which theoretically possible with the single chip solution.

### V. Advantages and features of DLP

#### A. The advantages of DLP

- a) Brighter: DLP projectors are among the brightest available because of DLP technology brings more light from lamp to screen, resulting in more effective presentations-even when ambient light is difficult to control.
- b) Sharper: DLP projections unique reflective technology comes closest to producing the exact mirror image of an incoming video or graphic signal, resulting in projection that's seamless at any resolution.
- c) Versatile: DLP technology allows projectors to be small and light, often weighing as little as 1kg making them Versatile enough for use in conference rooms, living rooms, classrooms.
- d) More reliable: Display systems using DLP technology are able to recreate their incoming source material with each projection
- e) Consistent picture quality: A data projector based on DLP
5. Land and latch: the bias is turned on to capture the rotationally separated mirrors and change them to rotate to the addressed states, and so settle.
6. Update memory array (one time at a time): the bias remains turned on to stay the Mirrors secured thus on forestall them from responding to changes within the memory whereas the memory is written with new video information.
7. Repeat sequence starting at step one.

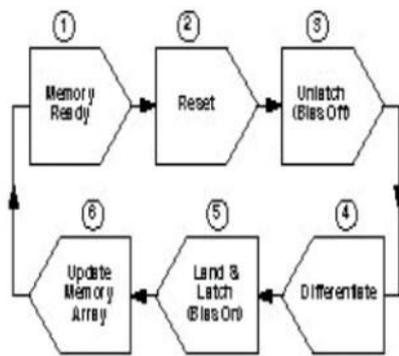


Figure 11. DMD address and reset sequence

Figure: DMD address and reset sequence.

The bias voltage has 3 functions. First, it produces a bitable condition to attenuate the address voltage demand, as antecedently mentioned. During this manner, giant rotation angles are often achieved with standard 5-volt CMOS. Second, it electromechanically latches the mirrors in order that they can't answer changes within the address voltage till the mirrors area unit reset. The third perform of the bias is to reset the pixels in order that they'll faithfully cut loose of surface adhesive forces and start to rotate to their new address states.

### VI. TYPES OF PROJECTORS

There are unit 2 sorts of DLP PROJECTOR are as follows:

- 1) Single chip projector
- 2) 3 chip projector

Let's see one by one

#### SINGLE-CHIP PROJECTORS

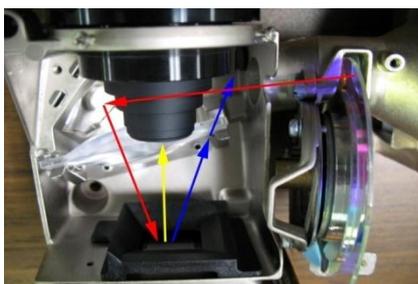


Fig: single chip projector

Interior read of one chip DLP projector show within the light-weight path. Light from the land enters a reverse-fisheye, passes through the spinning colourwheel crosses underneath main lens, reflects of a front-surfaced mirror, and is spread into the DMD (red arrows). From there, light either enters the lens (yellow) or is reflected off the top cover down into a light-sink (blue arrows) to absorb unneeded light.

In a projector with a single DLP chip, colors are produced either by placing a color wheel between a white lamp and the DLP chip or by using individual light sources to produce the primary colors, LEDs or lasers for example. The color wheel is divided into multiple sectors: the primary additive colors: red, green, and blue, and in many cases white (clear). Newer systems substitute the primary subtractive colors cyan, magenta, and yellow for white. The use of the subtractive colors is part of the newer color performance system called Brilliant Color which processes the additive colors along with the subtractive colors to create a broader spectrum of possible color combinations on the screen.

The DLP chip is synchronized with the rotating motion the color wheel so that the green component is displayed on the DMD when the green section of the color wheel is in front of the lamp. The same is true for the red, blue and other sections. The colors are thus displayed sequentially at a sufficiently high rate that the observer sees

### VII. Features of DLP

- [1] Clarity: DLP Technology comes nearer than the other show resolution reproducing the precise similitude of its supply material.
- [2] Brightness: DLP projection systems outshine the alternatives as a result of, being mirror primarily based; they use light-weight additional expeditiously.
- [3] Color: DLP Technology reproduces a variety of colors up to eight times bigger than of analogue projection systems. DLP projection creates wealthy blacks and darker shades than is feasible with alternative technologies.
- [4] Reliability: DLP Technology makes video projectors, home systems and televisions additional sturdy and reliable.
- [5] Life span: A DLP primarily based TV set ought to last indefinitely as a result of the digital micromirror device behind it's terribly reliable. There's no maintenance or alignment needed for DLP-based sets as they age.

### Conclusion

We have delineate the essential process blocks DLP has variety of potential uses on the far side theatre, TV and cine projector.

Other application that would incorporate its high definition image creation area unit pick finishing 3 dimensional visual displays, holographic storage, microscopes and medical imaging.

Scientist and developers area unit probably to get even additional uses for DMDs and DLP technology in future.

### REFERENCES

- [1] Larry J. Hornbeck, Digital light processing and MEMS: Timely convergence for bright future.
- [2] Larry J. Hornbeck: .Digital Light Processing: new MEMS – Based Display Technology
- [3] Larry J. Hornbeck: Digital light processing for high brightness high resolution applications.
- [4] GodlyKatal, NelofarTyagy, Ashish Joshi: Digital light processing its feature applications.