A

Seminar report

On

Digital Light Processing

Submitted in partial fulfillment of the requirement for the award of degree
of Bachelor of Technology in Computer Science

SUBMITTED TO: **SUBMITTED BY:**

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Acknowledgement

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Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

Preface

I have made this report file on the topic **Digital Light Processing;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Content

Introduction

Digital Light Processing is the one of primary display technologies driving this rapid growth and maturation .it is a revolutionary way to project and display information based on the Digital Micro Mirror Device (DMD) Digital Light processing was invented in 1987 by Texas Instruments it creates the final link to display digital visual information.

Digital Light Processing creates deeper blacks, conveys fast moving images very well and uses a single, replaceable, white -light bulb . it is available in both front-and rear-projection models DLP is an excellent choice for people who watch a lot of sports or fast-action movies because of the speed at which it creates an image.

DLP Structure

A Digital Micro Mirror Divice chip is the heart of Digital Light Processing projector, DMD can be described simply as a semiconductor light switch. The micro mirrors are mounted on the DMD chip and it tilts in response to an electrical signal. The tilt directs light toward the screen, or into a "light trap" that eliminates unwanted light when reproducing blacks and shadows. Other elements of a DLP projector include a light source, a colour filter system, a cooling system, illumination and projection optics.

A DLP based projector system includes memory and signal processing to support a fully digital approach. Depending on the application, a DLP system will accept either a digital or analog signal. Analog signals are converted into digital in the DLPs front –end processing. Any interlaced video signal is converted into an entire picture frame video signal through interpolative processing. The signal goes through DLP video processing and becomes progressive Red (R), Green (G) and Blue (B) data. The progressive RGB data is then formatted into entire binary bit planes of data.

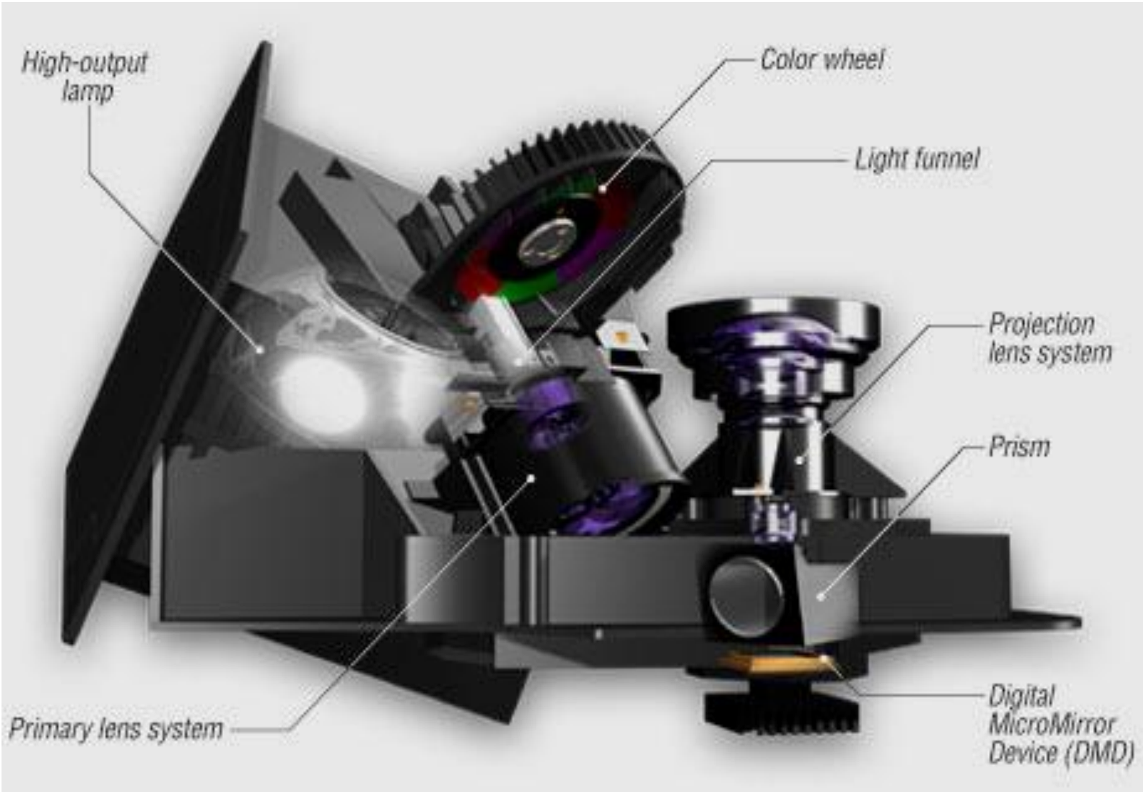

Fig. 2.1 DLP Projector internal structure.

DMD MODULATOR

The DMD modulator is a semiconductor light switch consisting of an array of micromechanical, individually addressable mirrors built over a single crystal silicon Static Random Access Memory backplane. Thousands of tiny, square mirrors, fabricated on hinges atop a static random access memory (SRAM), make up a DMD. Each mirror is capable of switching a pixel of light. The hinges allow the mirrors to tilt between two states, +10° for 'on' or -10 ° for 'off'. When the mirrors are not operating, they sit in a 'parked' state at 0°.

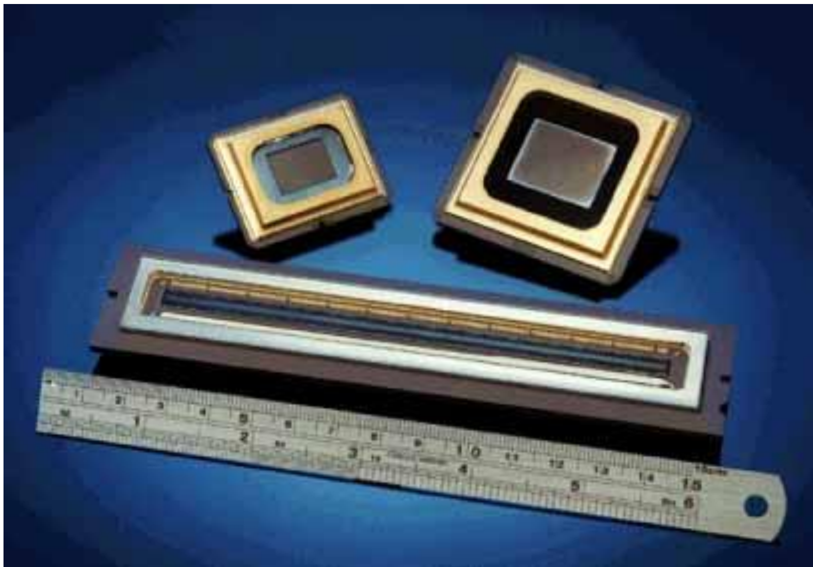

Fig. 2.2 A typical DMD Modulator.

This example has an array of 1024x768 individually addressable micromirrors.

The DMD chip is comprised of over one million mirrors. The size of each mirror is less than 1/5" the width of a human hair. The DMD is monolithically fabricated by Complementary Metal Oxide Semiconductor-like processes over a CMOS memory. Each light switch has an aluminum mirror, 16 μm^2 that can reflect light in one of two directions depending on the state of the underlying memory cell. Rotation of the mirror is accomplished through electrostatic attraction produced by voltage differences developed between the mirror and the underlying memory cell. With the memory cell in the on (1) state, the mirror rotates to +10°, with the memory cell in the off (0) state, the mirror rotates to -10°.

DMD MODULATER STRUCTURE

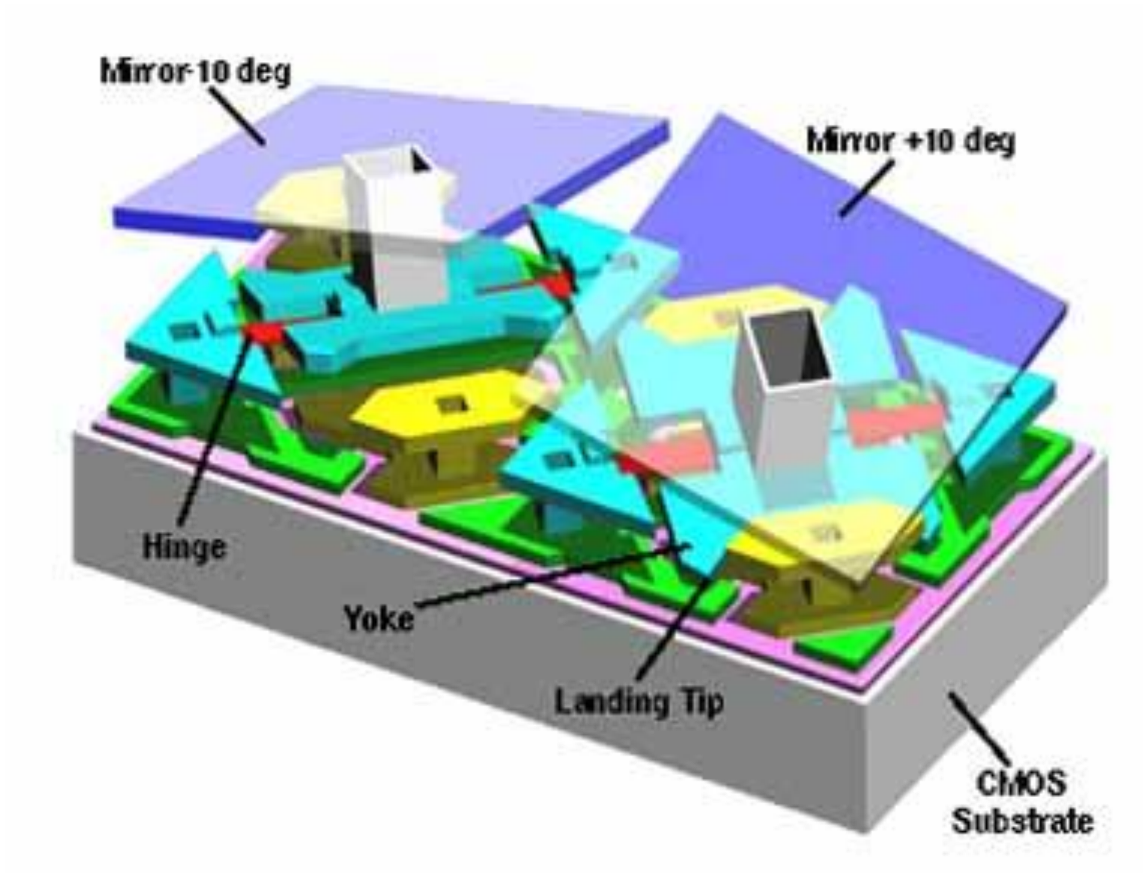

Fig. 2.3 Isometric schematic of DMD pixels.

The mechanical portion of each pixel consists of a three layer structure. The center layer, called beam layer, is suspended over the bottom electrode layer by thin torsion hinges. The top mirror layer is attached to the beam layer with a via post. The yoke may rotate about the torsion hinge axis to either side, landing on the electrode layer at specific tilt angles of +/- **10** degrees. Manipulation of the mirrors is accomplished electro statically utilizing the address electrodes on either side of the torsion hinge. These address electrodes are tied to the SRAM cell residing in the silicon backplane beneath each mirror structure.

After passing through condensing optics and a colour filter system, the light from the projection lamp is directed at the DMD. When the mirrors are in ‘on’ position, they reflect light through the projection lens and onto the screen to form a digital, square-pixel projected image. Each mirror on the DMD array is electro statically tilted to the 'on' or 'off' positions. The technique that determines how long each mirror tilts in either direction is called pulse width modulation. The mirrors are capable of switching on and off more than 1000 times a second this rapid speed allows digital gray-scale and colors reproduction.

DMD CELL ARCHITECTURE

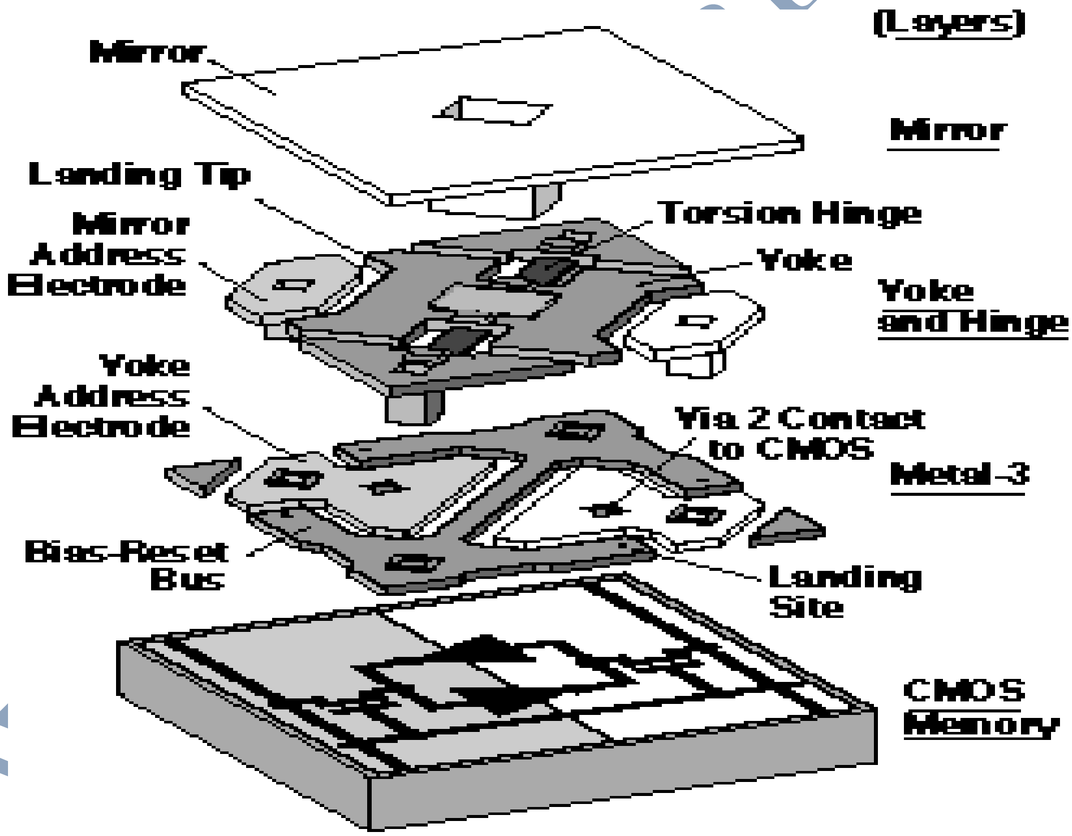

Figure 8. DMD pixel exploded view

Fig. 2.4 DMD cell architecture

The DMD pixel is a monolithically integrated MEMS superstructure cell fabricated over a CMOS SRAM cell. An organic sacrificial layer is removed by plasma etching to produce air gaps between the metal layers of the superstructure. The air gaps free the structure to rotate about two compliant torsion hinges. The mirror is rigidly connected to an underlying yoke. The yoke, in turn, is connected by two thin, mechanically compliant torsion hinges to support posts that are attached to the underlying substrate. The address electrodes for the mirror and yoke are connected to the complementary sides of the underlying SRAM cell.

The yoke and mirror are connected to a bias bus fabricated at the metal-3 layer. The bias bus interconnects the yoke and mirrors of each pixel to a bond pad at the chip perimeter. The DMD mirrors are 16 μm^2 and made of aluminum for maximum reflectivity. They are arrayed on 17 µm centers to form a matrix having a high fill factor (~90%). The high fill factor produces high efficiency for light use at the pixel level and a seamless (pixilation-free) projected image.

Electrostatic fields are developed between the mirror and its address electrode and the yoke and its address electrode, creating an efficient electrostatic torque. This torque works against the restoring torque of the hinges to produce mirror and yoke rotation in the positive or negative direction. The mirror and yoke rotate until the yoke comes to rest (or lands) against mechanical stops that are at the same potential as the yoke. Because geometry determines the rotation angle, as opposed to a balance of electrostatic torques employed in earlier analog devices, the rotation angle is precisely determined.

The fabrication of the DMD superstructure begins with a completed CMOS memory circuit. A thick oxide is deposited over metal-2 of the CMOS and then planarized using a chemical mechanical polish (CMP) technique. The CMP step provides a completely flat substrate for

DMD superstructure fabrication, ensuring that the projector's brightness uniformity and contrast ratio are not degraded.

Through the use of six photomask layers, the superstructure is formed with layers of aluminum for the address electrode (metal-3), hinge, yoke and mirror layers and hardened photo-resist for the sacrificial layers (spacer-1 and spacer-2) that form the two air gaps. The aluminum is sputter-deposited and plasma-etched using plasma-deposited SiO2 as the etch mask. Later in the packaging flow, the sacrificial layers are plasma-ashed to form the air gaps. The packaging flow begins with the wafers partially sawed along the chip scribe lines to a depth that will allow the chips to be easily broken apart later.

The partially sawed and cleaned wafers then proceed to a plasma etcher that is used to selectively strip the organic sacrificial layers from under the DMD mirror, yoke, and hinges. Following this process, a thin lubrication layer is deposited to prevent the landing tips of the yoke from adhering to the landing pads during operation. Before separating the chips from one another, each chip is tested for full electrical and optical functionality by a high-speed automated wafer tester.

ELECTRONIC OPERATION IN DMD CHIP

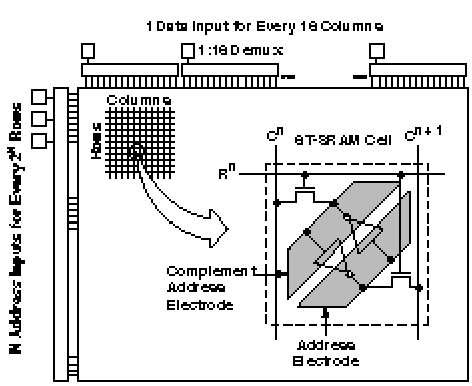

Figure 10. Organization of the DMD chip

Fig. 2.5 Organisation of DMD chip

The DMD pixel is inherently digital because of the way it is electronically driven. It is operated in an electrostatically bistable mode by the application of a bias voltage to the mirror to minimize the address voltage requirements. Thus, large rotation angles can be achieved with a conventional 5-volt CMOS address circuit. The organization of the DMD chip is shown in fig. Underlying each DMD mirror and mechanical superstructure cell is a six-transistor SRAM. Multiple data inputs and demultiplexers (1:16) are provided to match the frequency capability of the on-chip CMOS with the required video data rates.

The pulse width modulation scheme for the DMD requires that the video field time be divided into binary time intervals or bit times. During each bit time, while the mirrors of the array are modulating light, the underlying memory array is refreshed or updated for the next bit time. Once the memory array has been updated, all the mirrors in the array are released simultaneously and allowed to move to their new address states.

This simultaneous update of all mirrors, when coupled with the PWM bit-splitting algorithm, produces an inherently low-flicker display. Flicker is the visual artifact that can be produced in CRTs as a result of brightness decay with time of the phosphor. Because CRTs are refreshed in an interlaced scan-line format, there is both a line-to-line temporal phase shift in brightness as well as an overall decay in brightness. DLP-based displays have inherently low flicker because all pixels are updated at the same time (there is no line-to-line temporal phase shift) and because the PWM bit-splitting algorithm produces short-duration light pulses that are uniformly distributed throughout the video field time (no temporal decay in brightness).

Models of DLP

Like digital video camcorders, DLP devices come in either one or three chip models. One chip DLP systems use a projection lamp to pass white light through a colour wheel that sends red-green-blue colours to the DMD chip in a sequential order to create an image on-screen. Only one DMD chip is used to process the primary red, green and blue colours.

In three chip DLP systems use a projection lamp to send white light through a prism, which creates separate red, green and blue light beams. Each beam is send to their respective red, green and blue DMD chip to process the image for display on-screen. One chip models are said to produce a display of over 16-million colours. Three chip models can produce a display of over 35-trillion colours.

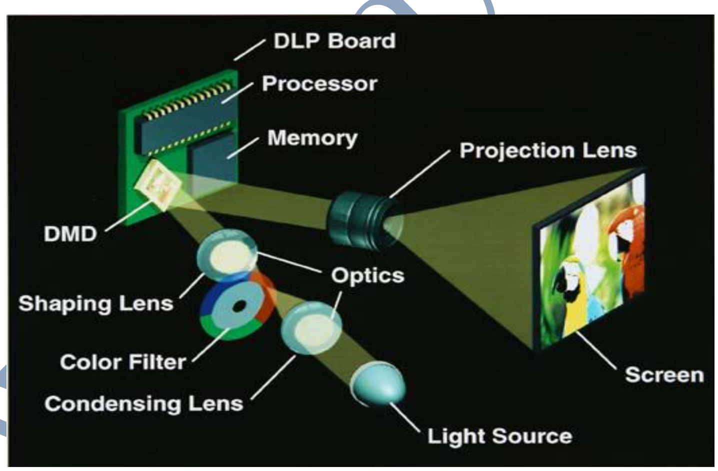

Fig. 3.1 Single chip model DLP

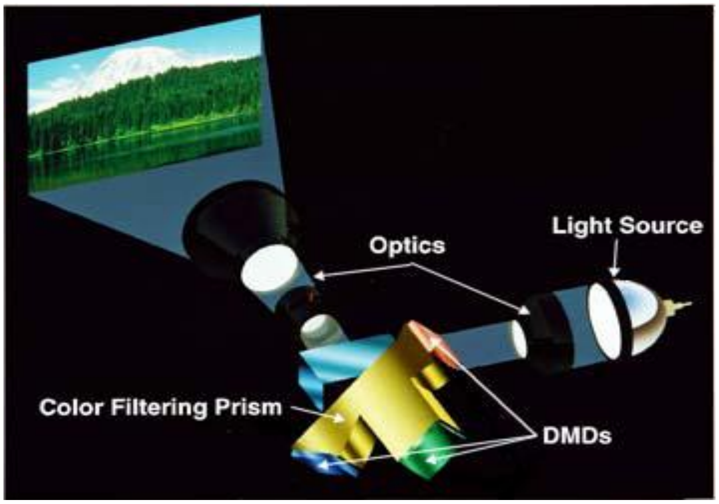

Fig. 3.2 Three chip model

Advantages of DLP

Brighter

DLP projectors are among the brightest available because DLP technology brings more light from lamp to screen, resulting in more effective presentation –even when ambient light is difficult to control.

Sharper

DLP projection's unique 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.

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 and classrooms.

More reliable

Display system using DLP technologies are able to recreate their incoming source material with each projection experience that will not fade over time.

Consistent picture quality

A data projector based on DLP technology delivers knockout picture quality again and again because , being all-digital, recreates its image source every time of use . unlike competing analogue technologies such as LCD, the semiconductor that makes DLP projection possible is virtually immune to heat, humidity vibration and other factors.

Conclusion

We have described the basic processing blocks DLP has a number of potential uses beyond home theatre, television and film projector.

Other application that could incorporate its high-definition image creation are photo finishing , three dimensional visual displays, holographic storage, microscopes and medical imaging. Scientist and developers are likely to discover even more uses for DMDs and DLP technology in the future.

References

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