DLP® Introduction

Topics

- DMD Trivia (Digital Micromirror Device)
- How does DLP Work?
- New Application Areas

DMD – Heart of the DLP® Technology

Lifetime
>100,000 hrs

Number of Mirrors
480,000 to >2,000,000

Mechanical Motion
discrete contacts

Mechanical Elements
Aluminum

Address Voltage
3.3-volt CMOS technology

Standard SC Processes
Low temp, sputter deposition, plasma etch

Over 20 Million Devices Shipped To-Date

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DLP® Products – Traditional Markets

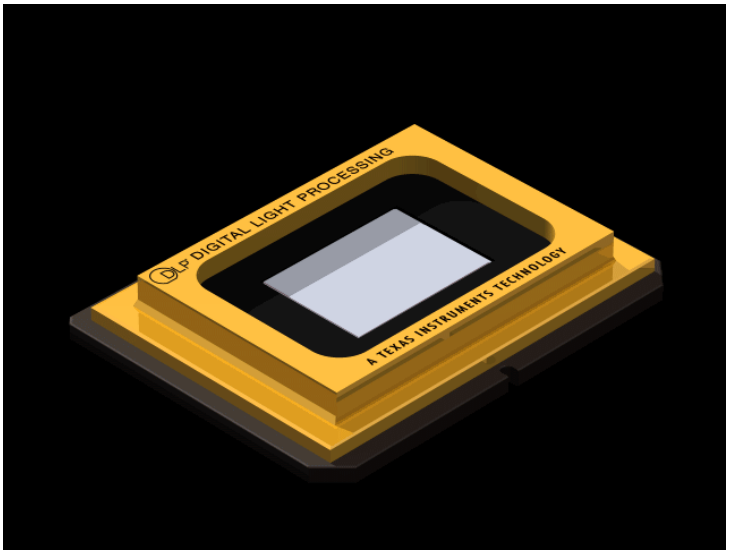
Cinema

Projectors

TV

Texas Instruments

The DMD In Operation



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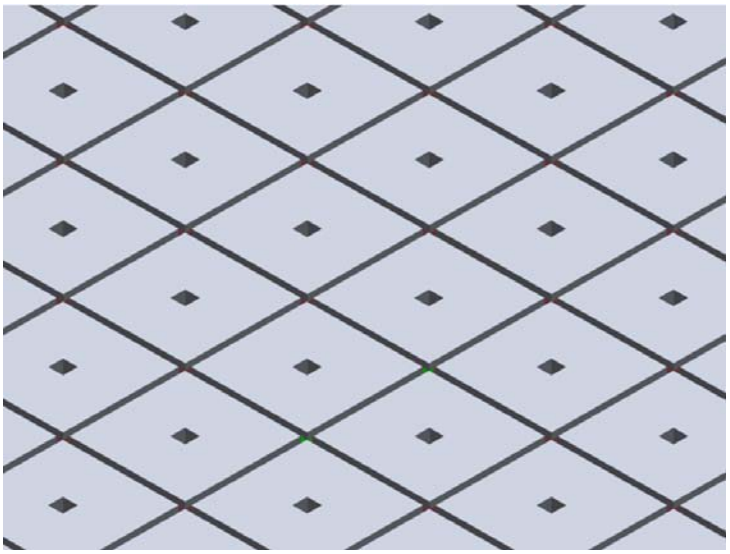
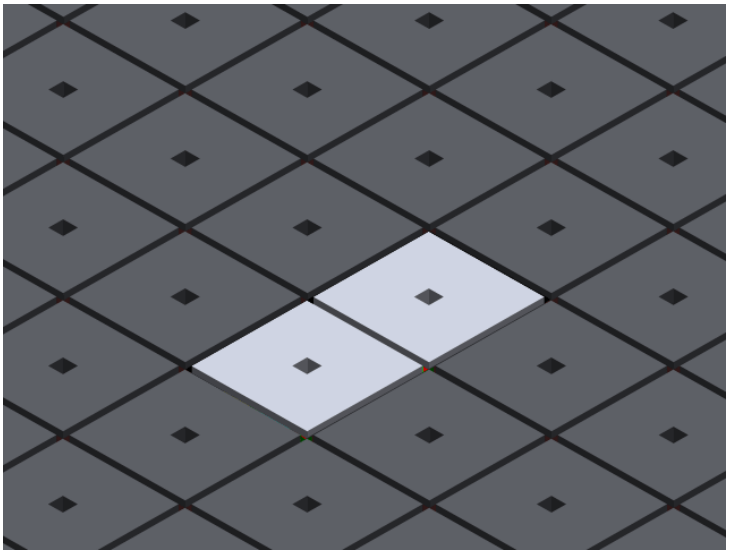
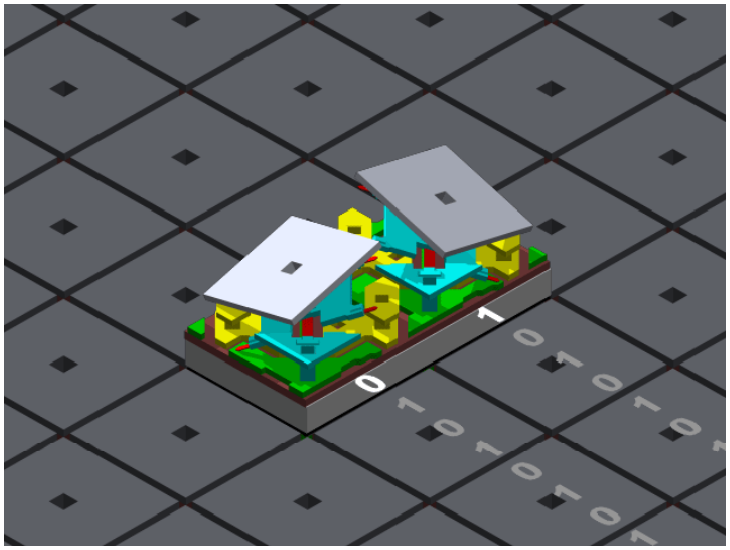
The DMD In Operation



The DMD In Operation



The DMD In Operation



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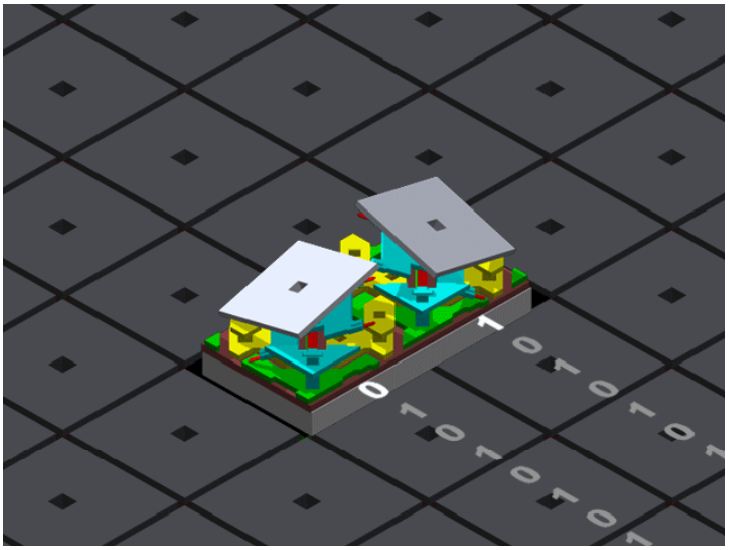
The DMD In Operation



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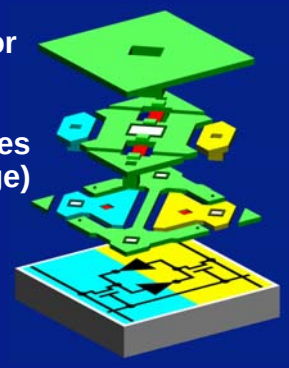
The Mirror

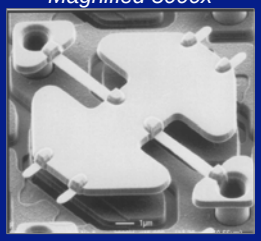
Control electrodes and yoke (hinge)

SRAM memory cell



- Switching Time
- < 20 usec (typical)

Magnified 5000x



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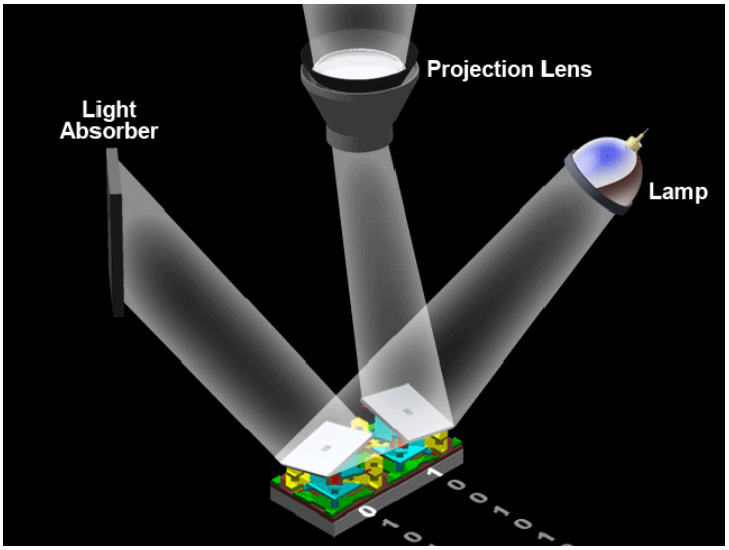
The DMD In Operation



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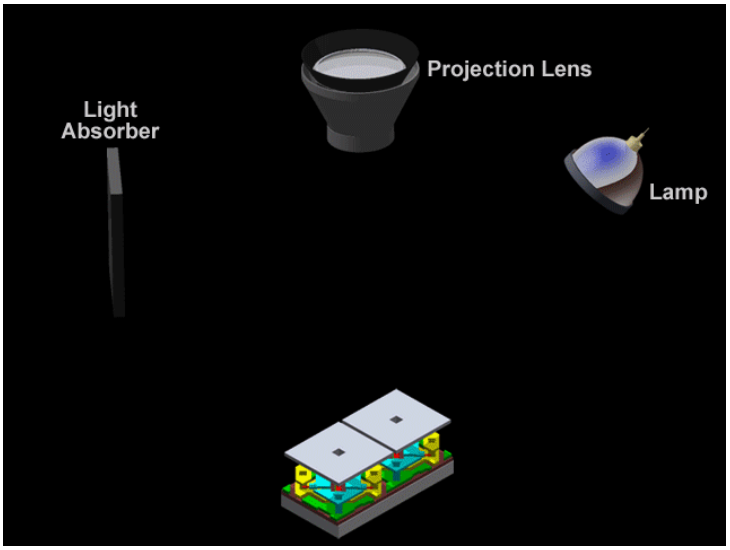
The DMD In Operation



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New Application Areas

Light Processing

Structured Lighting

- 3D Metrology, Machine Vision, Gaming

Spectroscopy

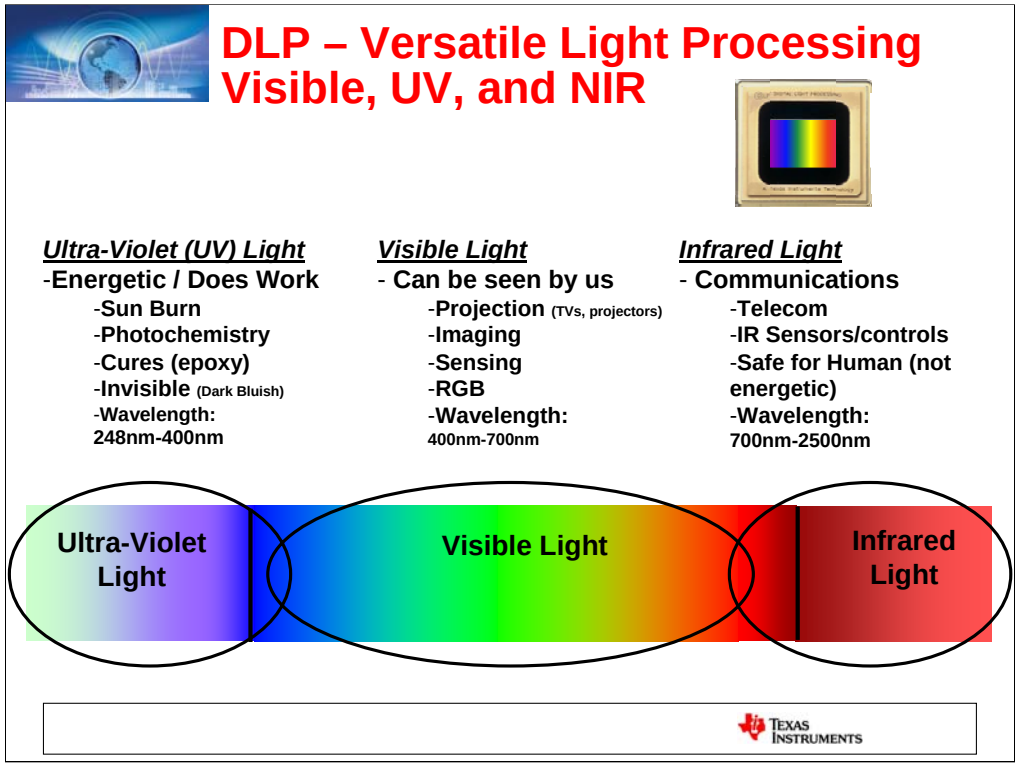
- Chemical Analysis, Mineral detection, purity

Medical

-Hyperspectral Imaging, Genomics

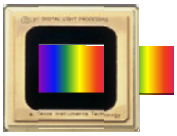
Industrial Ultraviolet Applications

- Lithography, Rapid Prototyping



DLP is only robust MEMs light processing that can handle UV to NIR. For example, LCOS and LCD have organic components that degrade rapidly under UV conditions or have to be customized to specific wavelengths in NIR, where as DLP is wavelength independent.

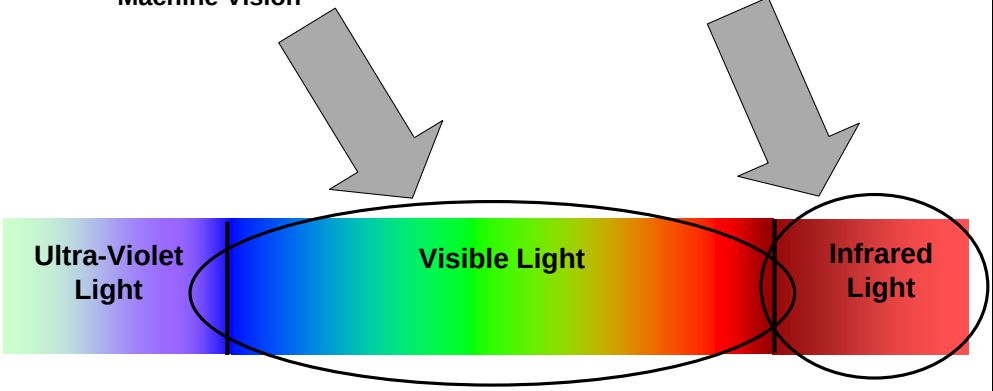
Spectrum of Opportunities



Structured Lighting

-3D metrology
-Inspection System
-Machine Vision

-Biometric Security
-3D Gaming



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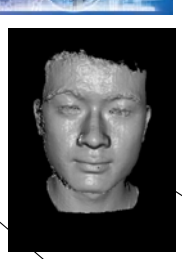
Basics of Structured Light

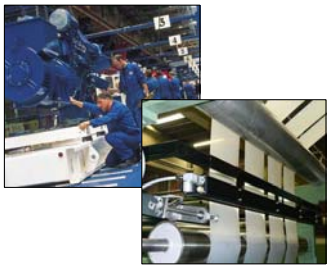


Key points:

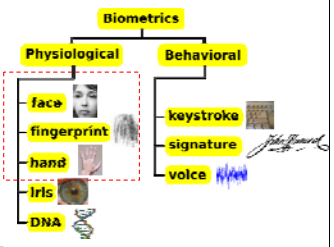
- Use a projector and a camera together to quickly create a 3D point cloud.
- Every camera pixel corresponds to exactly one ray.
- By projecting temporally coded vertical stripes, each projector ray can be identified.

Structure lighting applications

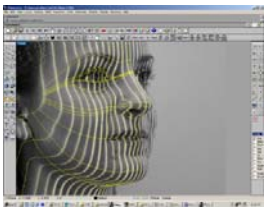
Machine Vision



Medical & Cosmetic Treatments



Biometrics



DLP Value:

-**Very high speed switching → Real time system (3D image capture in milliseconds)**
  - -**Fully automated factory line**
  - -**Facial recognition**
- -**High Resolution → Highly accurate**
  - **> 2 million pixels**
  - **> Micrometer (um) accuracy**

Industries:
- Casinos
- Airports / Travel
- Government access
- Financial institutes
- Corporate enterprises

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DLP provide

Spectroscopy

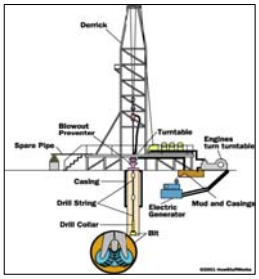
Definition

- **Spectroscopy is a measurement of a quantity as function of wavelength (visible and non-visible Light, Sound, Thermal, Photons)**

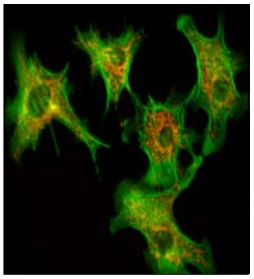
Advantages

- **Non-invasive and Non-destructive**
- **Fast with measurements in real time**

Oil, Gas & Minerals

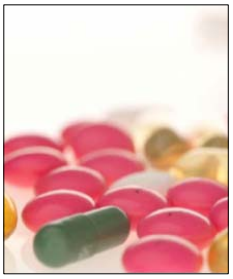


Medical



Purity Analysis

Chemical Composition



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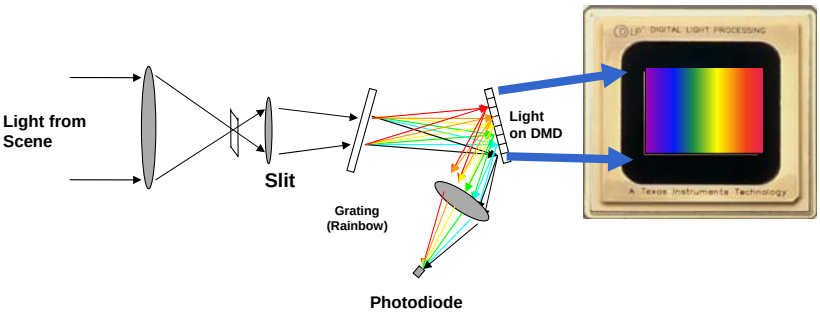
DMD is wavelength indepent

Advantages of DLP® for Spectroscopy



- High Speed & Resolution → Real time measurements
  - Millions of pixels switching in microseconds
- Large optical throughput → Increased measurement accuracy
  - Large die size .55" diagonal, enables higher SNR
- Reduced Cost
  - DLP reduces extremely costly diode arrays in NIR to a single affordable array

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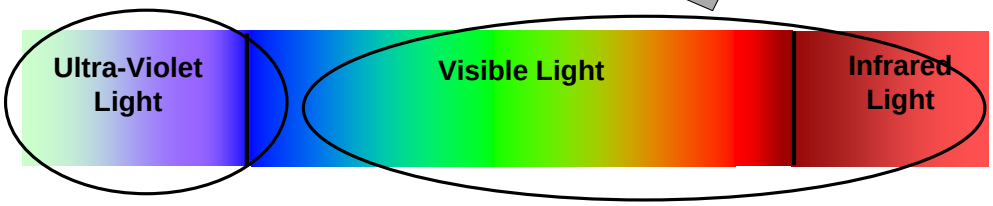
Photodiode arrays in the NIR are > $10K because they custom made GaAs arrays, where as DLP can use process. Single low cost diode can be as low as a few dollars.

Spectrum of Opportunities

Medical Applications

Photo-therapy
Bio-Medical Research
- Genomics
- Assay Development

Vascular Imaging
HyperSpectral Imaging



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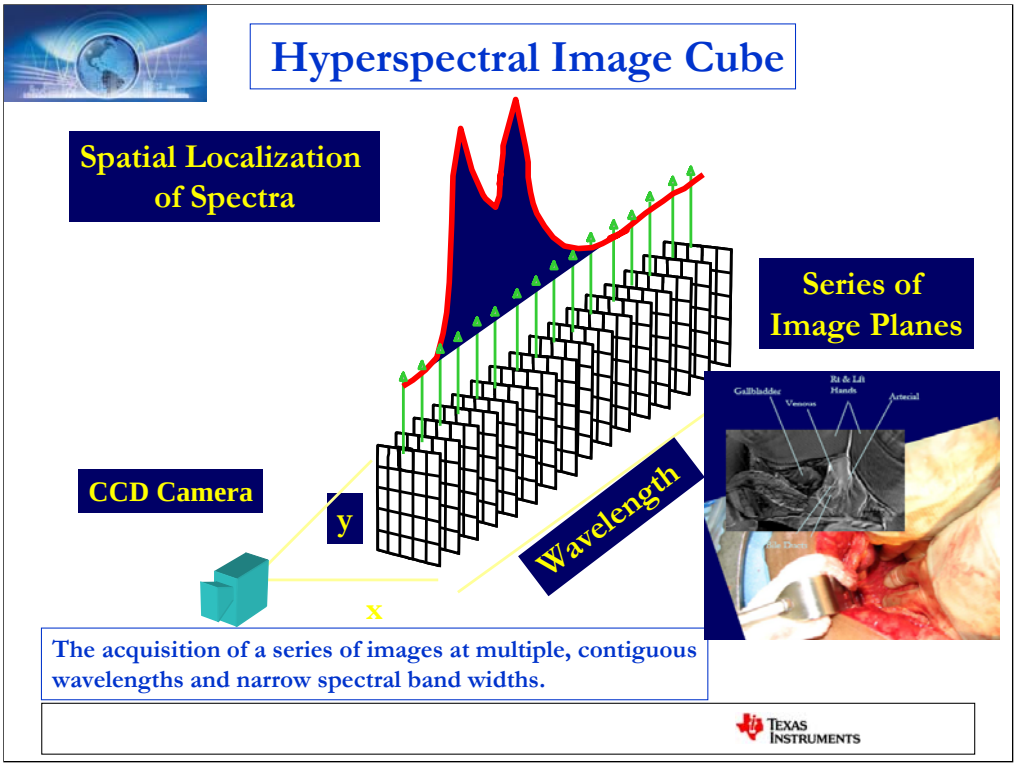
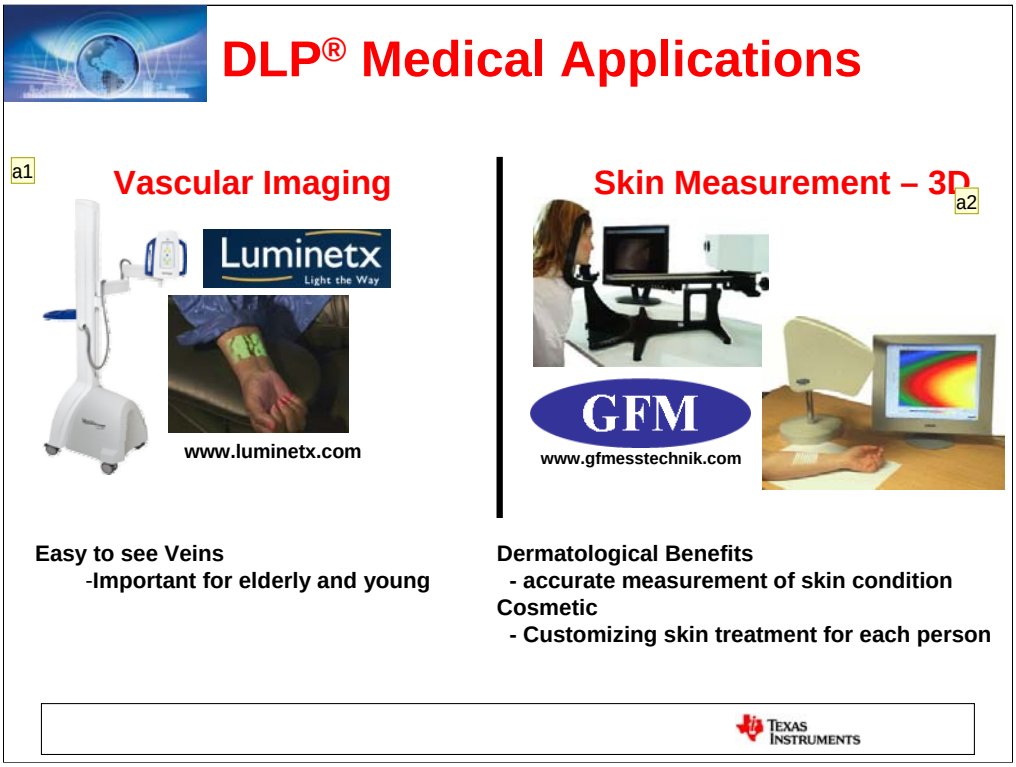
Clinical Hyperspectral Imaging Utilizing Texas Instruments DLP® Technology

Karel J. Zuzak, Ph.D.

The Laboratory of Biomedical Imaging, LBI



Projecting frequency light patterns in planes onto a surface and then capturing the images with a CCD - Camera



•For years the DMD has been considered for use in confocal as well as other forms of microscopy.

•In these applications, individual or groups of DMD mirrors are addressed to shape or scan the illumination or collection aperture of an optical microscope, thus acting as a dynamic slit or pinhole and eliminating the need for cumbersome and low performance mechanical scanning.

•Today thanks to the development by Luminetx the possibility of illuminating subcutaneous veins and imaging their exact location on the surface of the skin is possible.

- The VeinViewer device consists of four subsystems integrated into a compact device:
  - •An infrared illumination subsystem
  - •A digital video camera subsystem
  - •A digital image processing subsystem
  - •A digital projector subsystem.

•The infrared illumination process makes veins “visible” to the camera, which transmits live video to the processor at thirty frames per second. Software in the processor enhances the images and digitally aligns them for output. DLP technology is being used as a miniaturized projector that exactly overlays the photographed anatomy with the image of the underlying veins.

•Advantages:

- •Fewer needle sticks - Allows for a reduction in overall pain, discomfort and stress
- •Removes the clinician's "guesswork" in locating a vein - VeinViewer shows both the position and orientation of the vein, first time, every time!
- •VeinViewer can be used on all patients needing venous access
- •Can successfully locate difficult-to-find veins in patients
- •Both the patient and the clinician can see the location of the vein
- •Increases patient satisfaction and confidence
- •Allows for a quicker response time to patient treatment

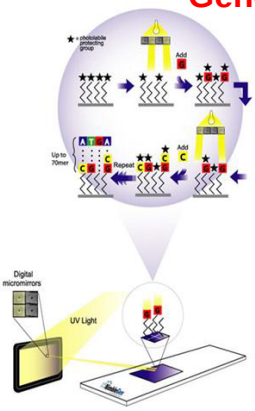
Slide 23

a1 Luminetx (VeinViewer) - Available in the market today. Uses infrared light source and a camera to collect the image of the veins which have reduced absorption, the image from the infrared camera is processed and sent to the DMD which is used to project the image onto the "arm" / object of interest.
a0179595, 1/21/2008

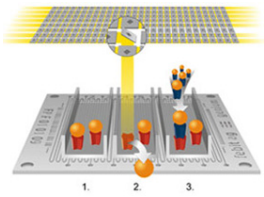
a2 GFM - Primos System (utilizes structured light patterns projected by the DMD onto the surface of interest (e.g., wrinkles on the face) and analysis of the reflected image collected on a CCD camera to determine the 3D contours of the face to be used for quantitative analysis (e.g., our cream / procedure really does reduce wrinkles by 30%!).
a0179595, 1/21/2008

DLP® Medical Applications

Genomics



Chhabra1



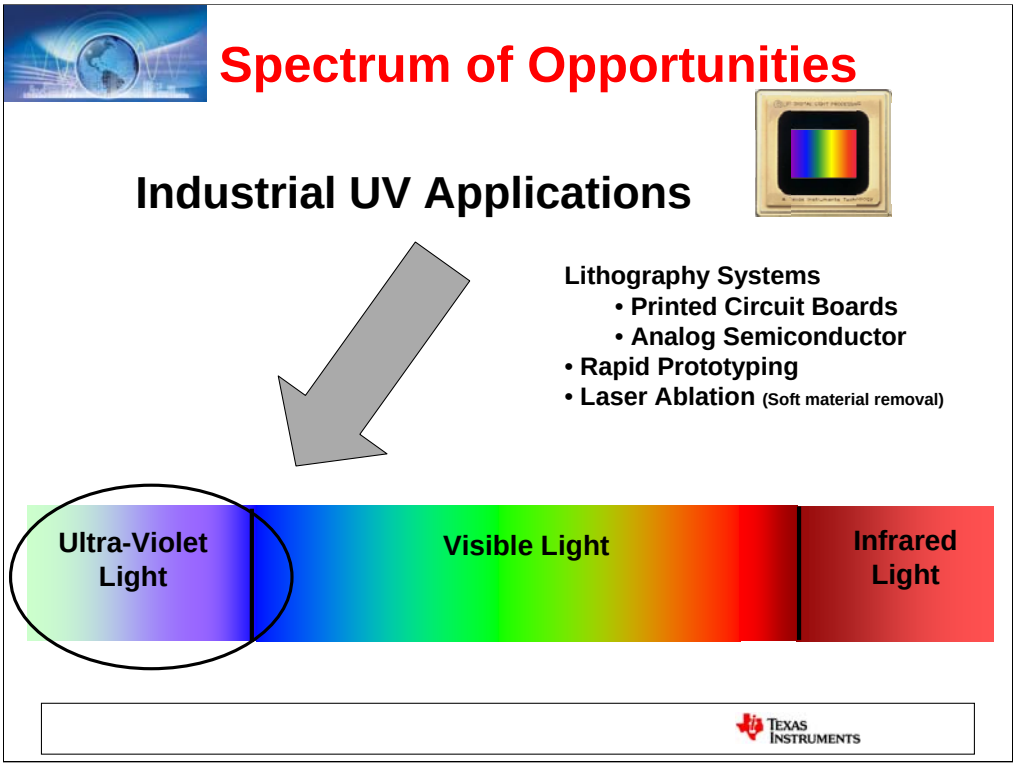
NimbleGen SYSTEMS, INC.
www.nimblegen.com

febit
www.febit.de

Assay Development

Slide 24

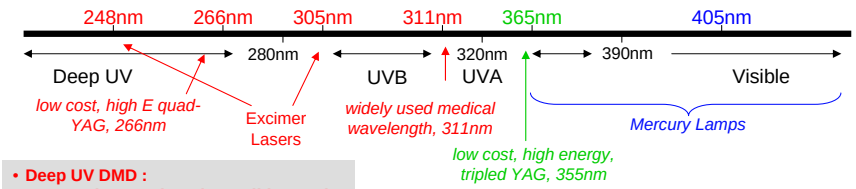
Chhabra1 Genomics - gene chip fabrication. In these systems the DMD is basically used as a maskless photolithography tool. The DMD directs uv light onto the "gene chip" surface in specific locations (based on system programming which turns mirrors on or off to match the desired pattern) to "deprotect" the location to allow DNA building blocks to be added. Users can create their own microarrays tailored to their specific needs and applications.
Arun Chhabra, 3/17/2008



UV light is highly energetic and does work and by its nature is usually a controlled device (e.g. medical equipment or industrial, and not consumer)

DLP is very highly valuable part.

UltraViolet (UV) & Deep UV applications



- **Deep UV DMD :**
  - **Analog Semiconductor lithography down to .2um**
  - **High speed ablation**
  - **Phototherapy (311nm)**
  - **Lasik, TFT (248nm)**

- **UV-A 365nm:**
  - **PCB Lithography**
  - **Rapid Prototyping**
  - **Medical Research**

- **Standard DMDs (Visible)**
  - **Lithography & CTcP (Printing) using highly sensitive photoresist**

- DLP is only volume production Light Processor that can work in High Power UV light
- DLP Chips are proven to be reliable in production Lithography systems

Industrial UV Direct Imaging “Maskless” Lithography (Now in production!)

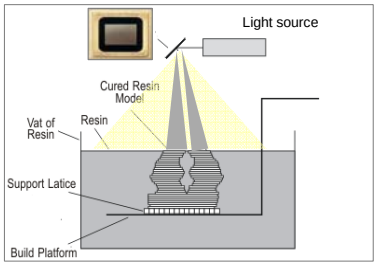
Key DLP Value:
-Removes the need for Mask based processing
  -Save significant cost and overhead
-Enables rapid prototyping
  -No need for custom tooling
-Reduced lead time

Hitachi Via

BasysPrint

Texas Instruments

Stereolithography or Rapid Prototyping



- **Use DLP® technology to define patterns from a vat of photo-definable material to create 3D models (from CAD drawings)**
- **Faster technology as compared to scanning laser**
  - **From hours to minutes**
- **Can work with materials such as Polypropylene, glass-filled Nylon, aluminum oxide, silicon oxide, and paraffin wax.**

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>500 customers

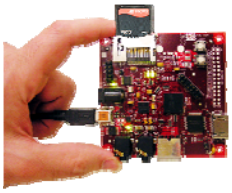
Macro trends

DLP value / differentiation

Current DLP® Development Kits

DLP Discovery 4000
- High performance
- Control of individual mirrors
- NIR and UV DMD offerings
- Direct access to DMD to adapt custom illumination and optics

DLP Pico Projector Development Kit
- Very small form factor
- Complete light engine (3 LED & optics)
- Specifically designed to interface to Beagle Board
  - OMAP processing capability
  - open source Linux support
  - various peripherals attach for development needs



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Thank you

Any Questions?

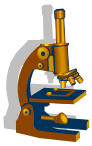
Back-up

University Research Areas

Examples

semiconductor exposure apparatus

using DMD for wavelength detection



fluorescence microscopy

research for maskless lithography

LED-based light engine for voltage-sensitive dye neuroimaging

microscope controlled polymer fabrication

stimulation interface for neurons

optical atom trap

experimental confocal microscope

classroom demo unit for imaging science

high speed 3D shape digitizer

diffractive experiments in a physics class

electrokinetic mixing

dynamic photo simulation device to define spatio-temporal input patterns.

neuroscience research

research for Volumetric display

3D surface acquisition for optomechanics and biomechanics

dispersed spectrum for vision research project

inverse scattering reconstruction

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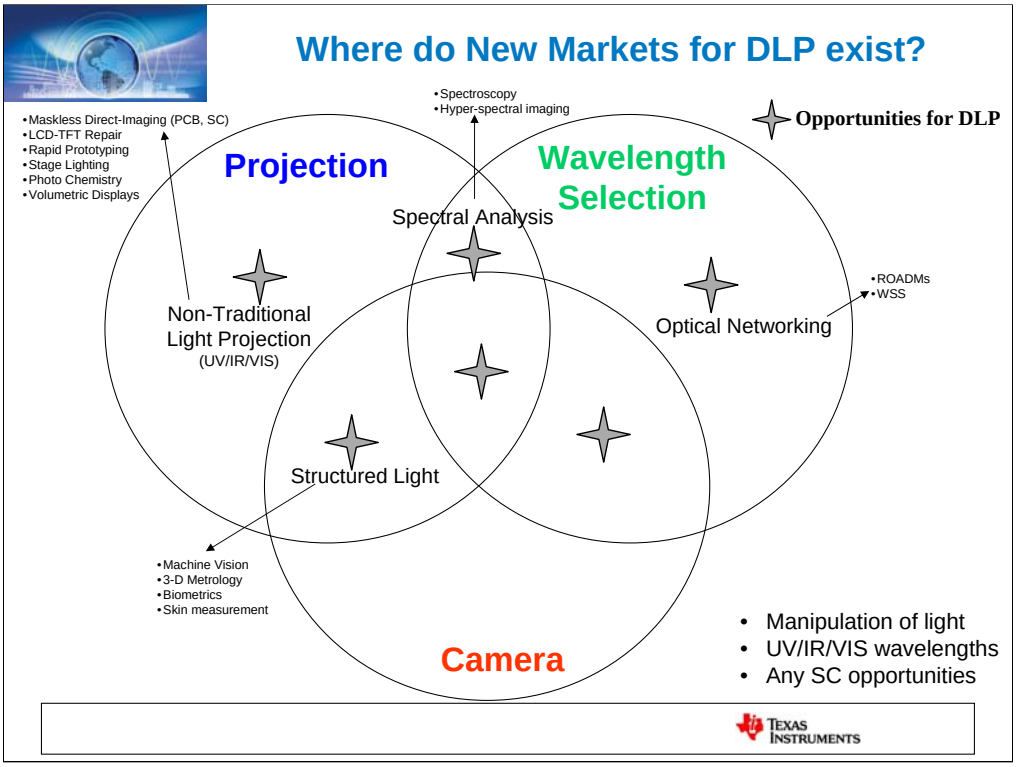
Where do New Markets for DLP exist?
•Maskless Direct-Imaging (PCB, SC)
•LCD-TFT Repair
•Rapid Prototyping
•Stage Lighting
•Photo Chemistry
•Volumetric Displays
•Spectroscopy
•Hyper-spectral imaging
Opportunities for DLP
Projection
Wavelength Selection
Spectral Analysis
Non-Traditional Light Projection
(UV/IR/VIS)
Optical Networking
•ROADMs
•WSS
Structured Light
•Machine Vision
•3-D Metrology
•Biometrics
•Skin measurement
Camera
• Manipulation of light
• UV/IR/VIS wavelengths
• Any SC opportunities
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