

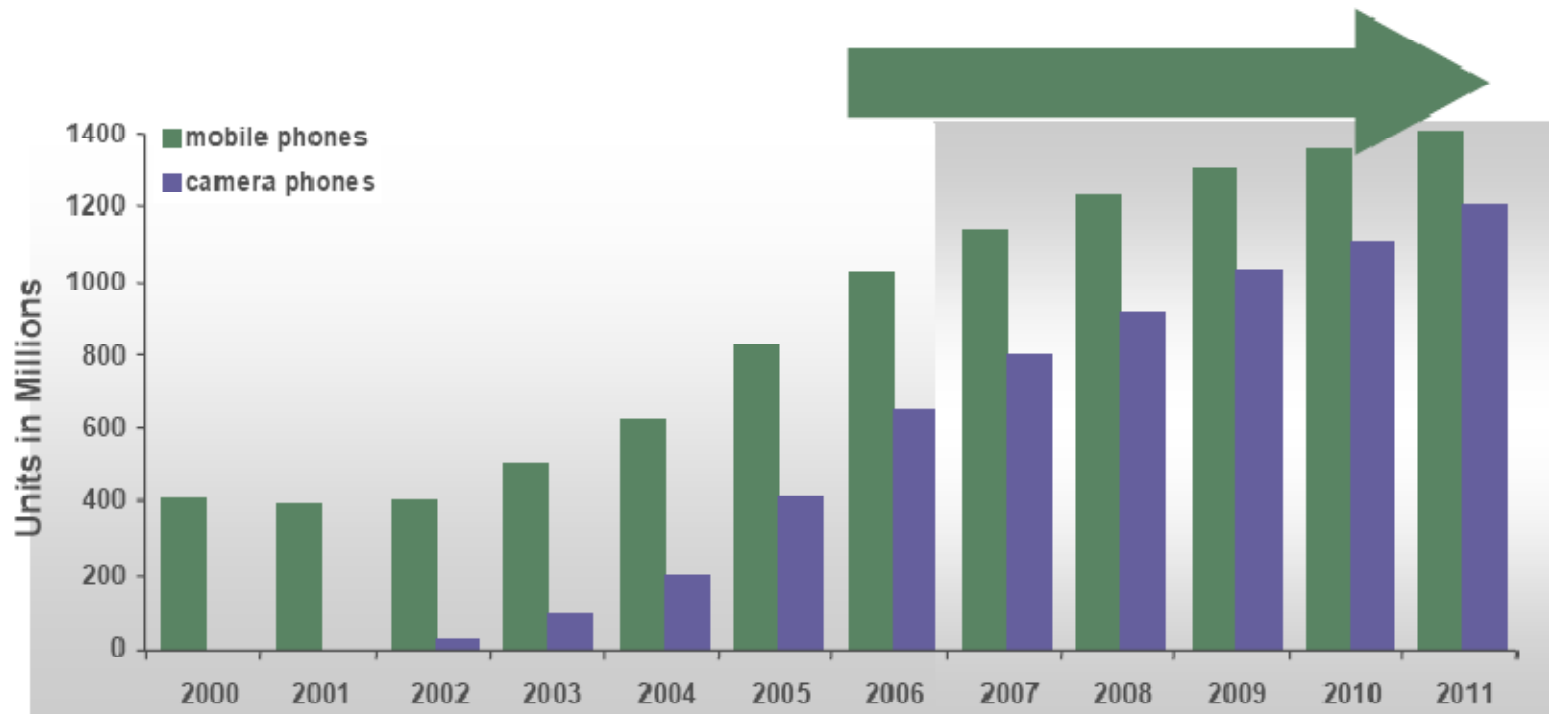
Ramesh Raskar

Camera Culture

Associate Professor, MIT Media Lab

<http://raskar.info>

Integration of Cameras in Mobile Phones



Cell phone Cameras are Everywhere



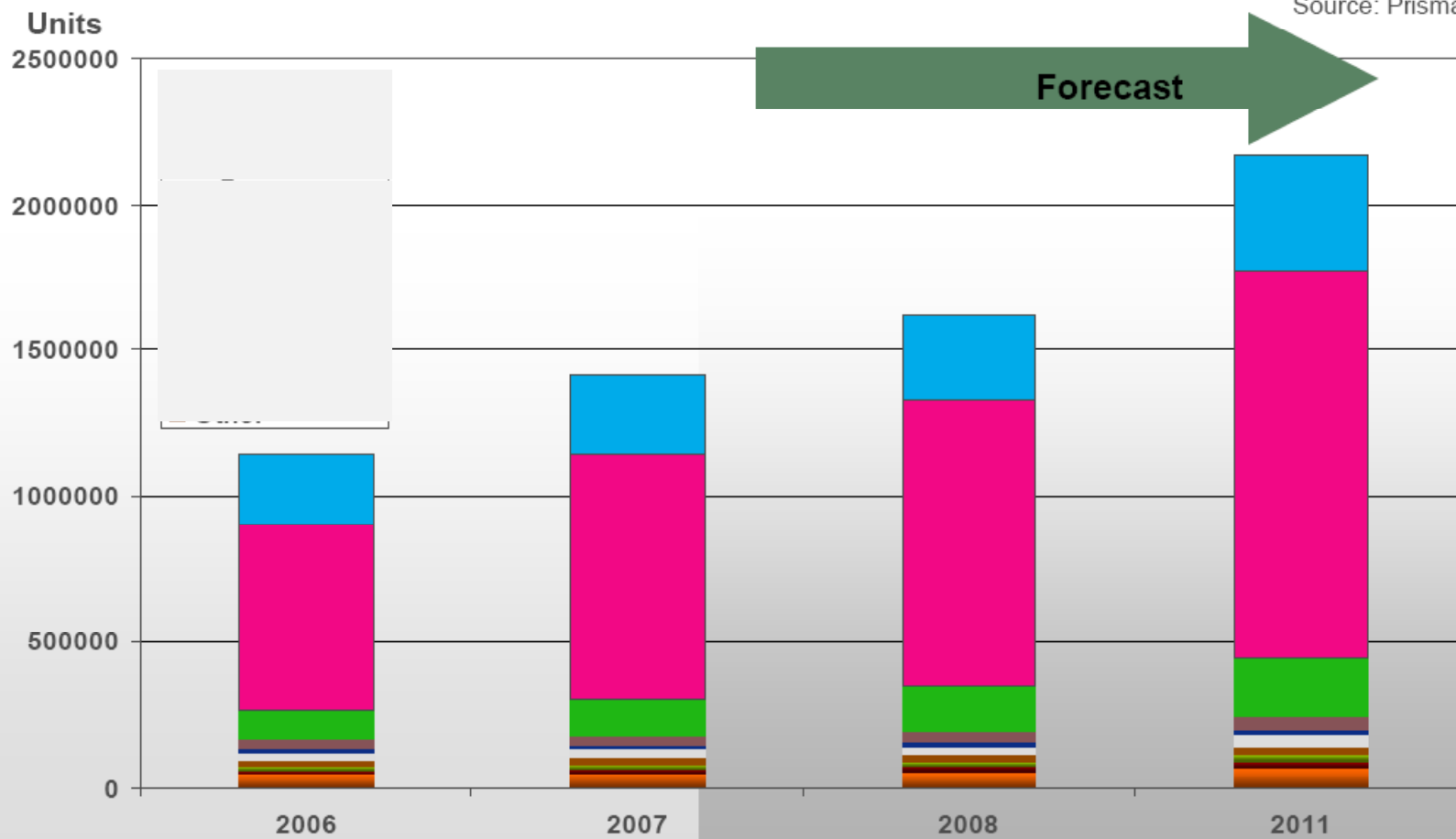
Kush R. Varshney, "Jagannath Temple," Puri, Orissa, India, Dec. 2007.

Where are the 'camera's?

Image Sensors Markets



Source: Prismark, March 2008



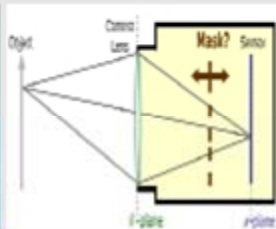

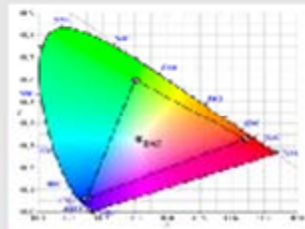
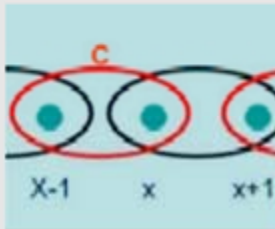


Camera Culture
MIT Media Lab

+ + +



We focus on creating tools to better capture and share visual information via a **new class of imaging platforms**

Coded <u>Time</u> (Exposure)	Coding in <u>Space</u>		Coded <u>Illumination</u>	Coded <u>Wavelength</u>	Coded <u>Sensing</u>
Flutter Shutter Cam	Coded Aperture	Optical Heterodyning	Multi-flash Camera	Agile Spectrum	Gradient Processing
					

What is the Media Lab?

MIT Media Lab
www.media.mit.edu

A Graduate Program in the Media Arts & Sciences

Houses ~150 students and 30 PIs

A Research Lab that spans across disciplines and academic/ industrial lines

65 sponsor companies

Sponsors get free, non-exclusive licenses for ML IP



Founded in 1985 by
Nicholas Negroponte and Jerome Wiesner



New Building
To open: Fall 2009



Close Ties With Industry



Our 65 corporate sponsors include some of the most creative companies in the world

ML Technologies Into The World

Media Lab develops **core/enabling IP**

Sponsors develop and bring **proprietary applications** to market, sometimes via graduate recruitment:



LEGO Mindstorms



NTT Comware SenseTable



Cleanup Corporation "Eat Your Media"



Fisher Price Symphony Painter



Hallmark Cards With Sound

Faculty/Graduates **spin off companies** and develop inventions further:



SMALL DESIGN FIRM INC.



Intuitive Automata



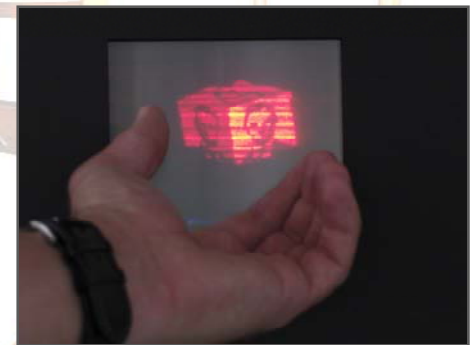
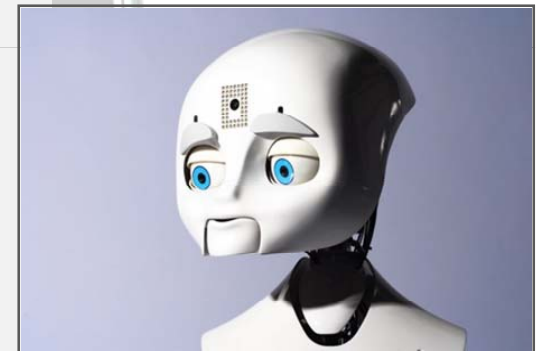
New Major Media Laboratory Initiatives

- The logo for the Center for Future Banking features a stylized graphic of two overlapping loops, one blue and one red, on a black background. The text "Center for" is on the left and "Future Banking" is on the right, both in white.
- The logo for the Center for Future Civic Media features a stylized graphic of a fan-like shape composed of many small blue dots on a black background. The text "CENTER FOR" is in white and "FUTURE CIVIC MEDIA" is in blue, both positioned below the graphic.
- Center for Future Storytelling

Center for Future Storytelling



- Launched with 7-year, \$25M funding with Plymouth Rock Studios
 - Opportunities for participation by other organizations
 - Satellite lab facility to open at Plymouth Rock in 2010
- 3 Co-Directors
 - Michael Bove (Object Based Media and Displays)
 - Cynthia Breazeal (Sociable Robots)
 - Ramesh Raskar (Cameras, Performance Capture)
 - + Technical/Creative Advisor (Gloriana Davenport)
- Making stories more interactive, improvisational, social
- Managing the tension between the “master storyteller” and a dynamic, pervasive viewing/listening environment
- Developing new production, distribution, and display technologies



MIT Media Laboratory

Smart Cities



What if cars could stack like shopping carts in cities?

Ryan Chin
PhD Candidate
Smart Cities group

William J. Mitchell
Professor of Architecture and
Media Arts and Sciences

Bio-
Mechatronics



Music/Mind/
Health



Neuro-
Media



**HUMAN
ADAPTABILITY**

Synthetic Neurobiology
Tue at 11am
Vinay Gidvaney

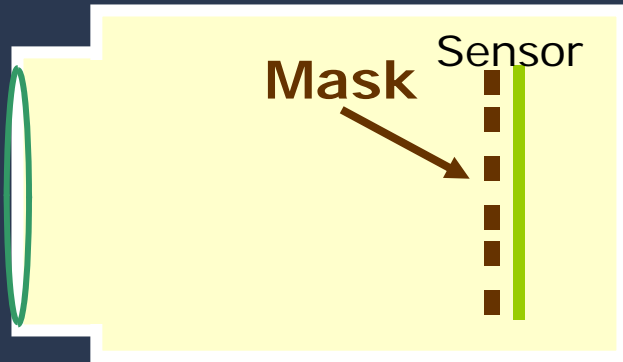


People -
Sense



Sociable
Robots

Mask based Light Field Camera



Digital Refocusing

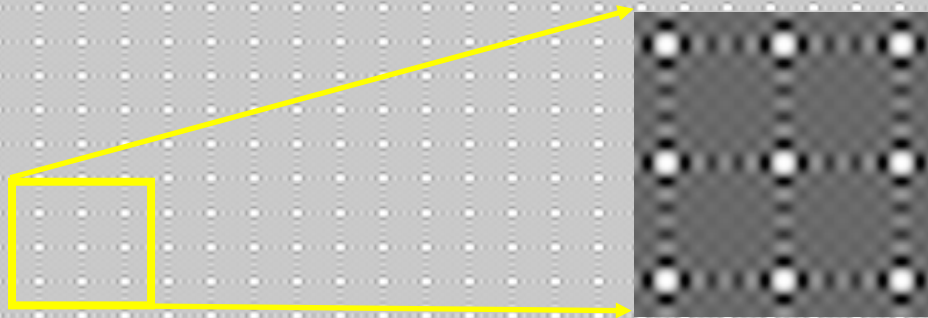


[Ng et al 2005]

Can we achieve this with a Mask alone?

Cosine Mask Used

Mask Tile



$$\frac{1}{f_0}$$

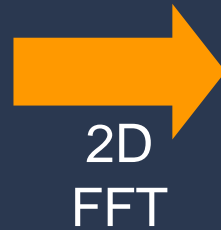
Captured 2D Photo



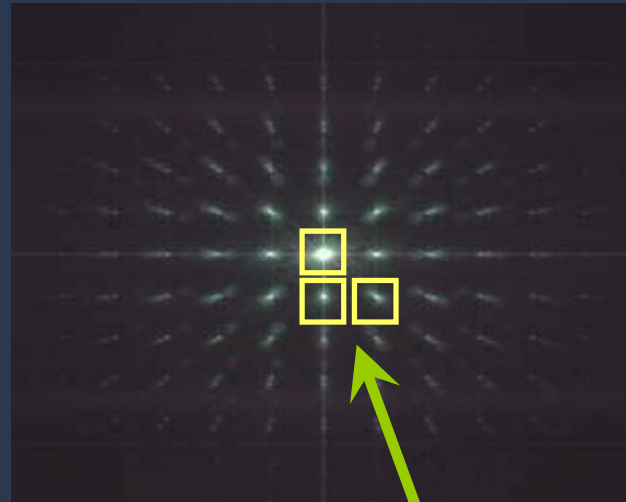
Encoding due to
Mask

Computing 4D Light Field

2D Sensor Photo, 1800*1800



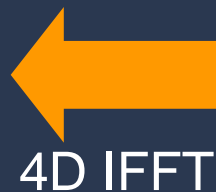
2D Fourier Transform, 1800*1800



$9*9=81$ spectral copies



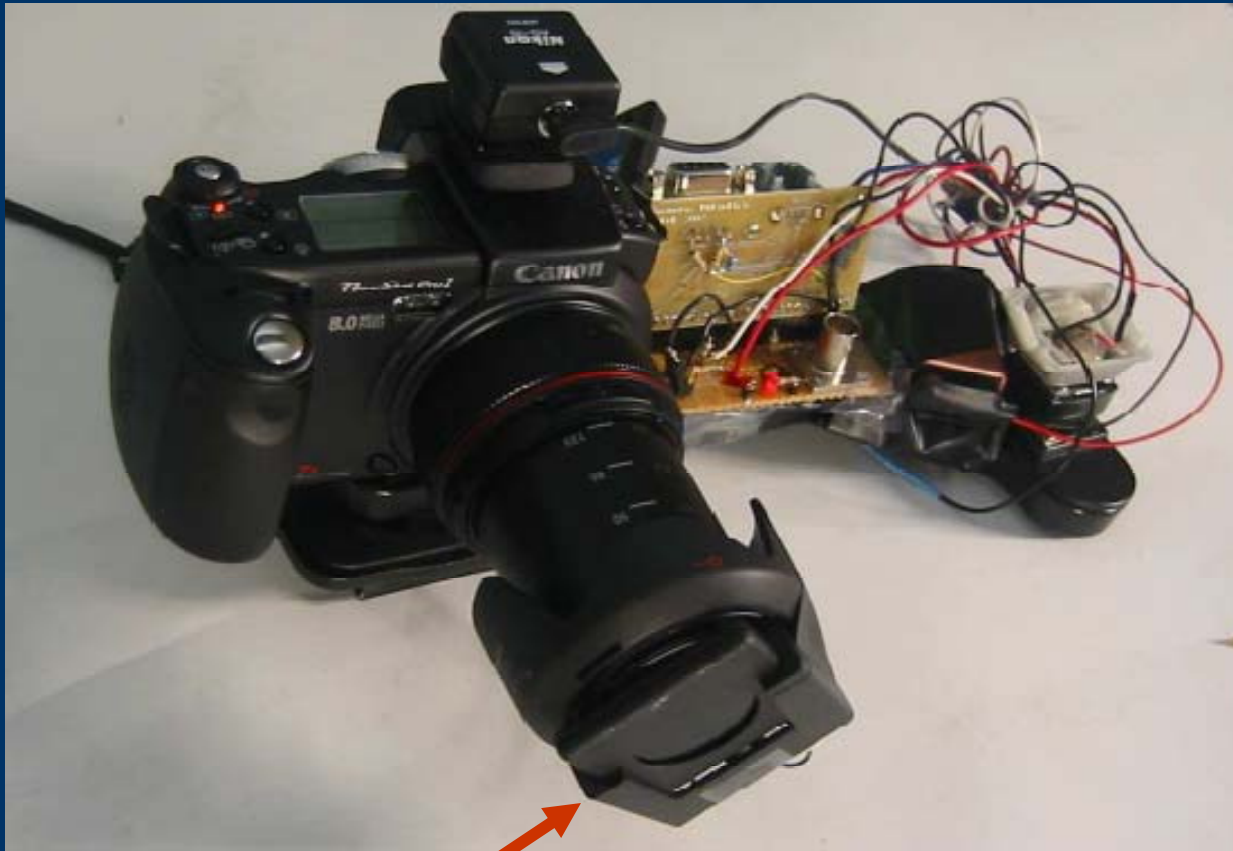
Rearrange 2D tiles into 4D
 $200*200*9*9$
planes



4D Light Field
 $200*200*9*9$

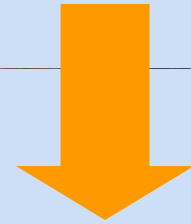
Flutter Shutter Camera

Raskar, Agrawal, Tumblin [Siggraph2006]



LCD opacity switched
in coded sequence

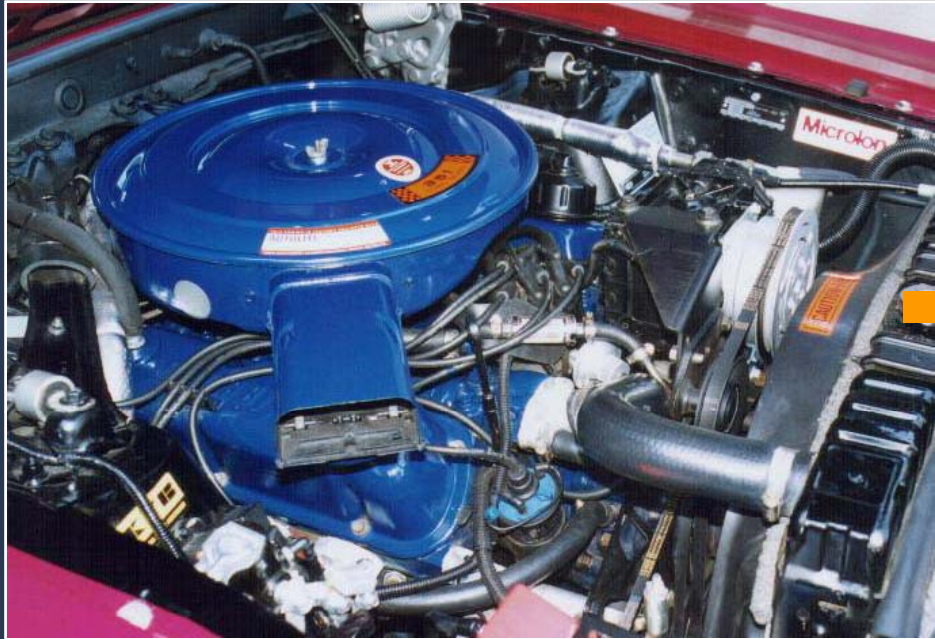






What are the problems with 'real' photo in conveying information ?

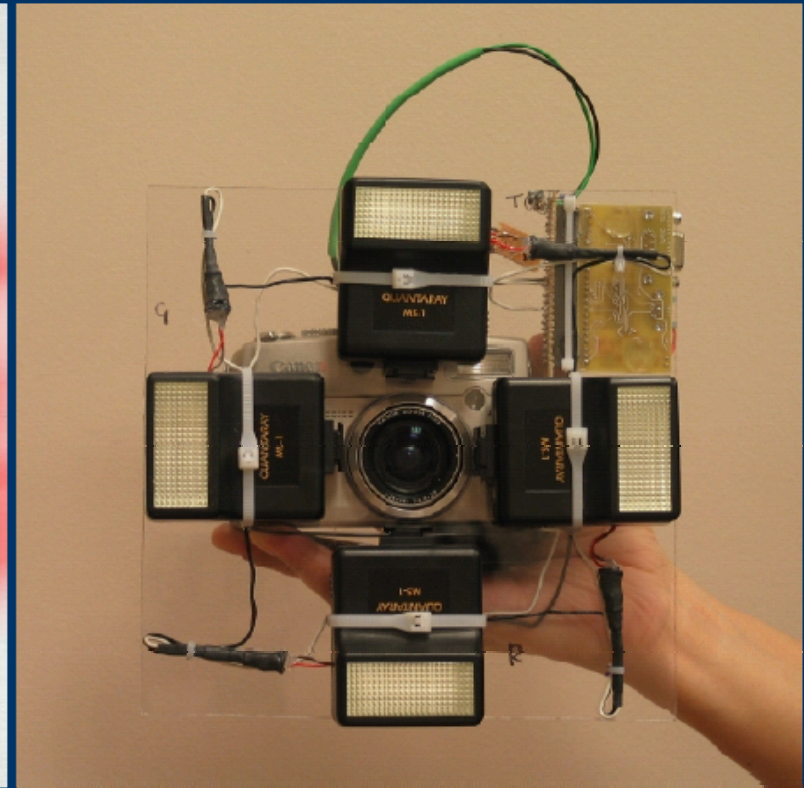
Why do we hire artists to draw what can be photographed ?

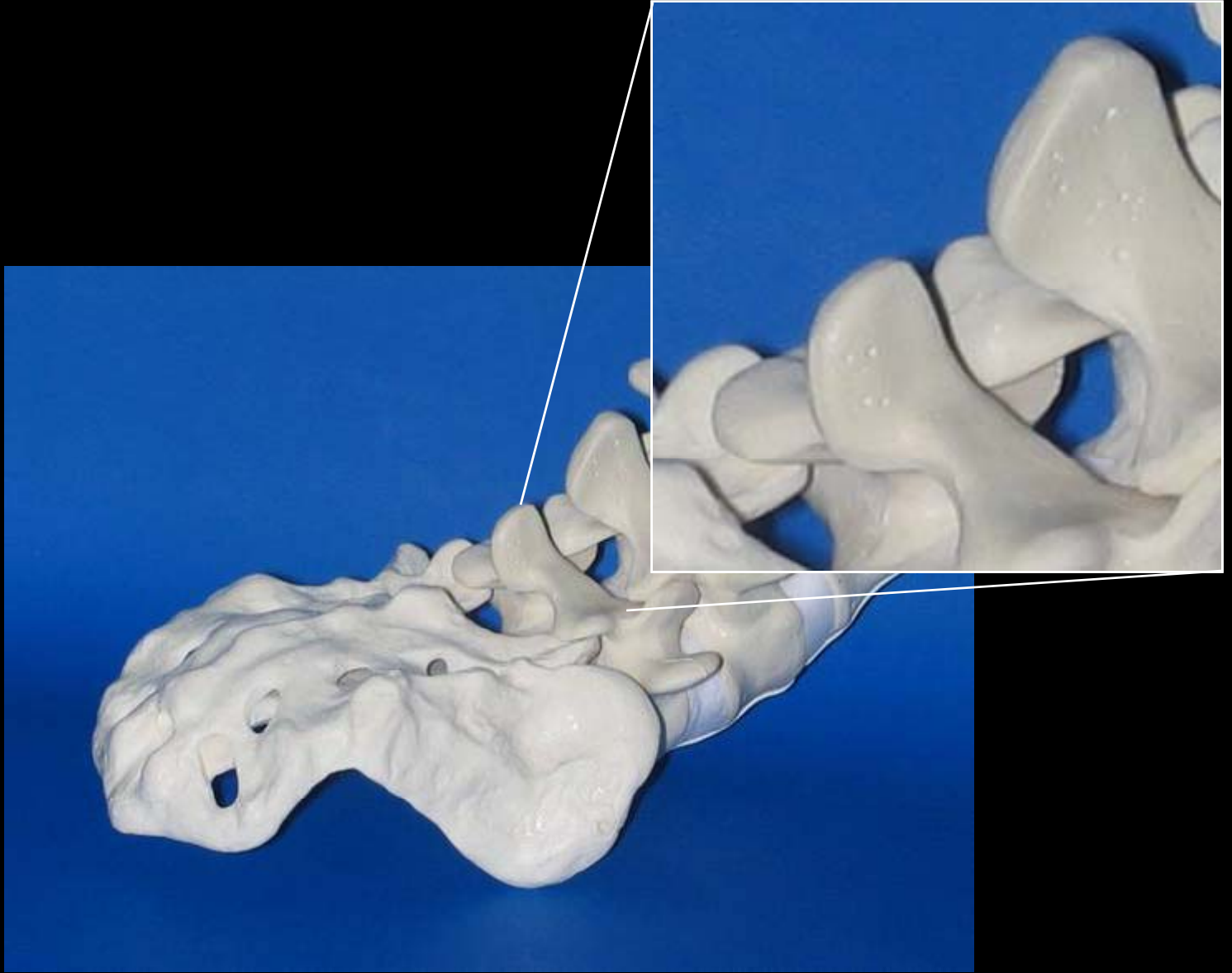
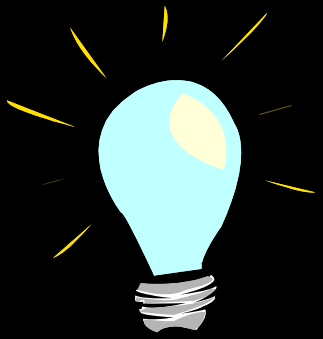


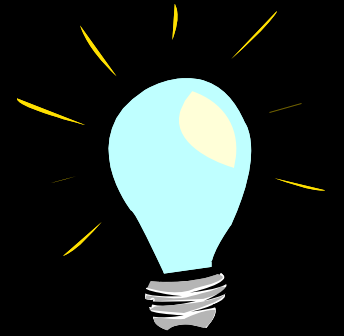
Shadows
Clutter
Many Colors

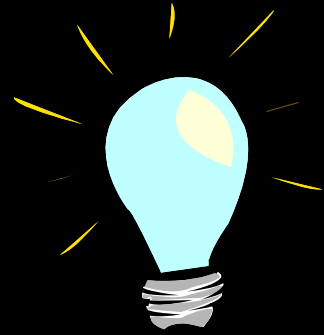
Highlight Shape Edges
Mark moving parts
Basic colors

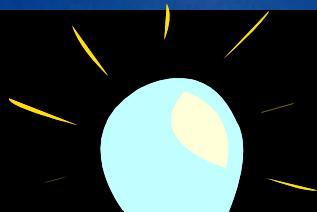
Cartoon Camera Using Depth Edges

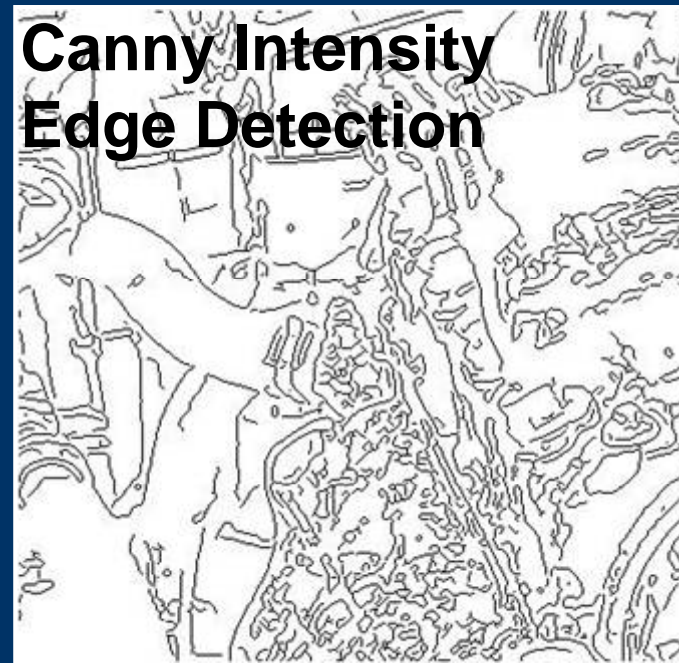
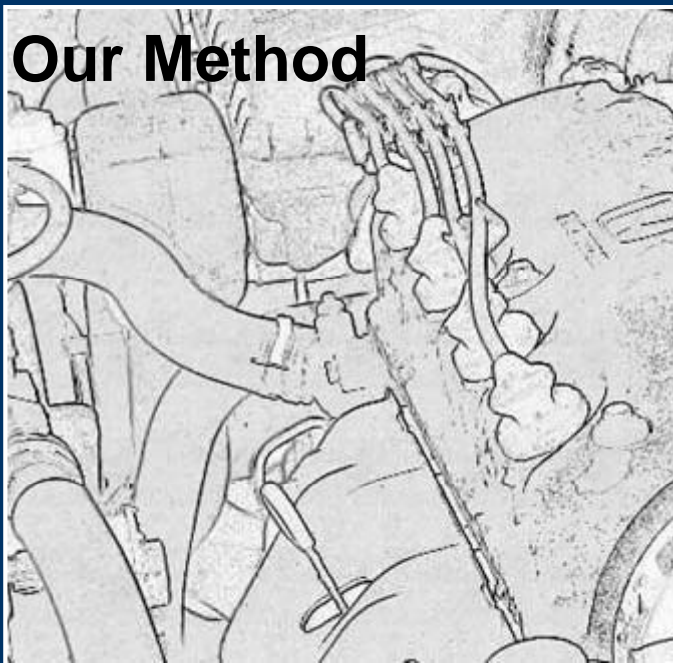








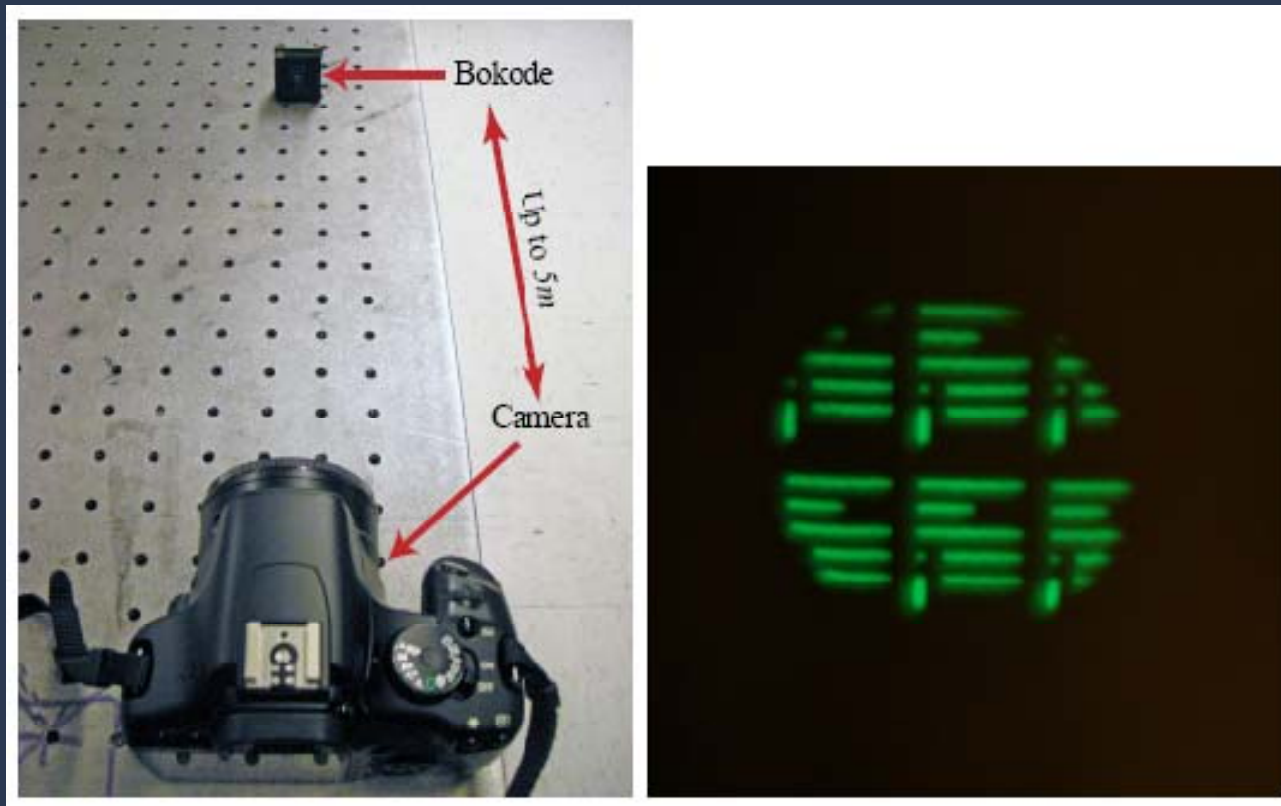






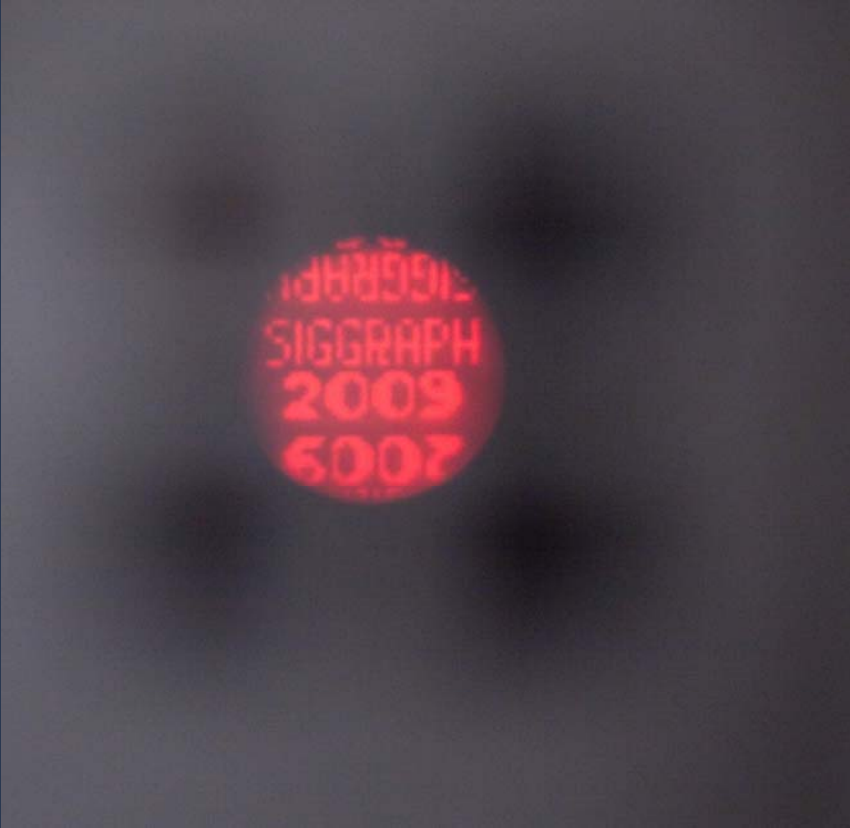
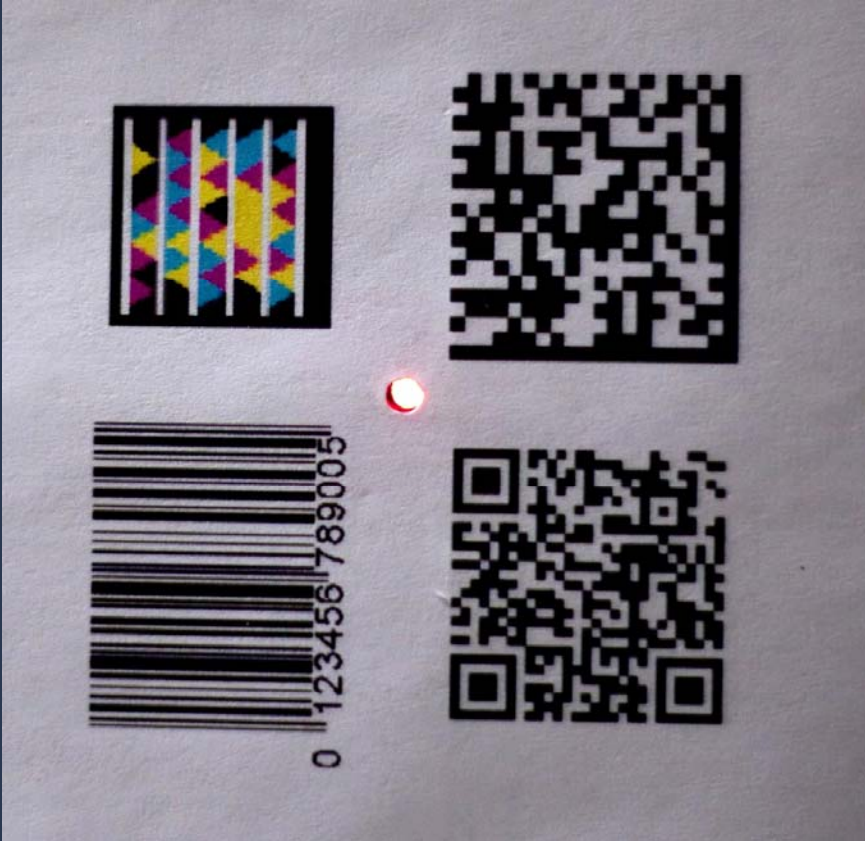
Long Distance Bar-codes

- Smart Barcode size : 3mm x 3mm
- Ordinary Camera: Distance 3 meter



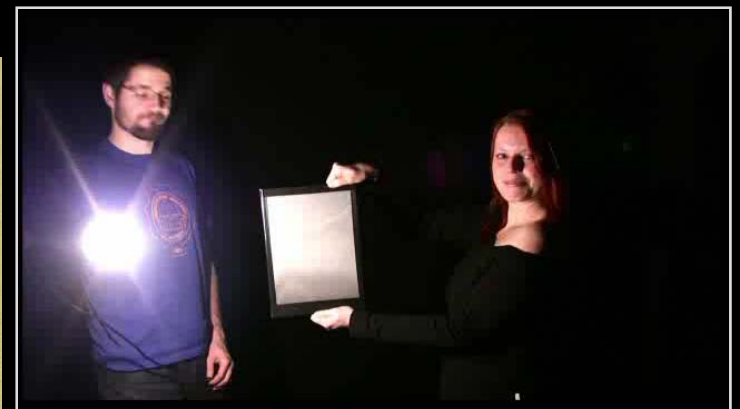
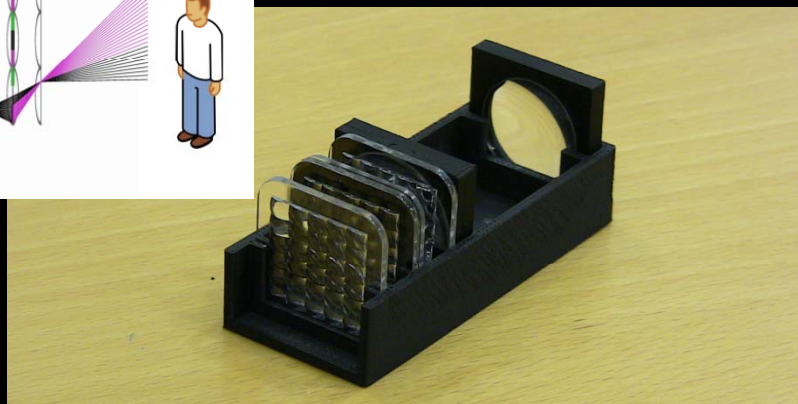
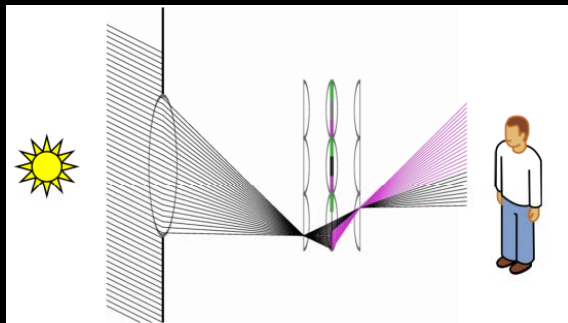
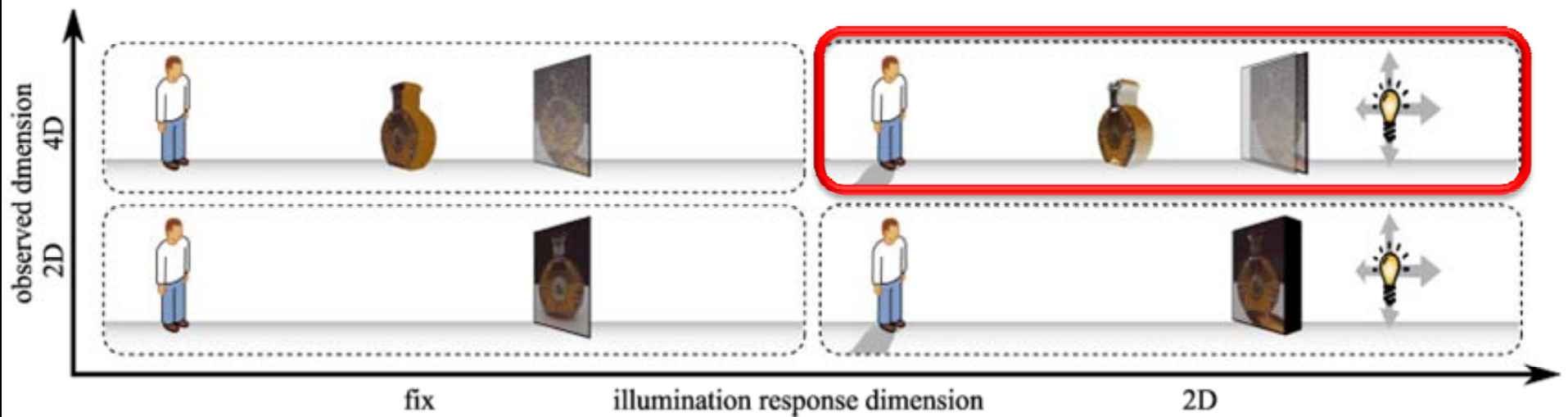
Woo, Mohan, Raskar, [2008]

Bokeh-based Code



6D Display

Light sensitive 4D display

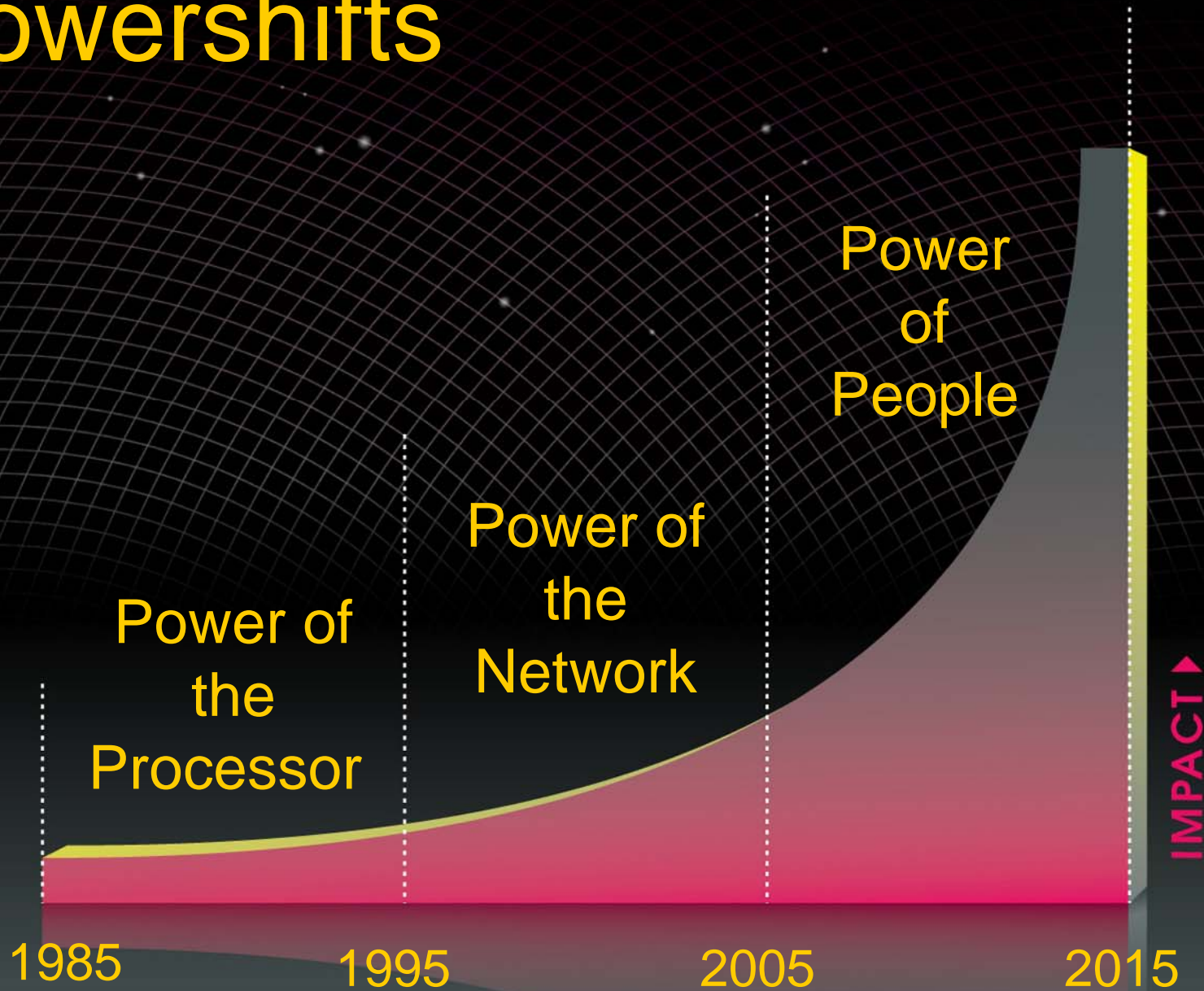


One Pixel of a 6D Display = 4D Display

Visual Computing

- Forward (Synthesis)
 - Special Effects, Image Processing, Design
- Inverse (Understand)
 - Human-like performance
 - Recognizing/finding objects, image search
 - Challenging !

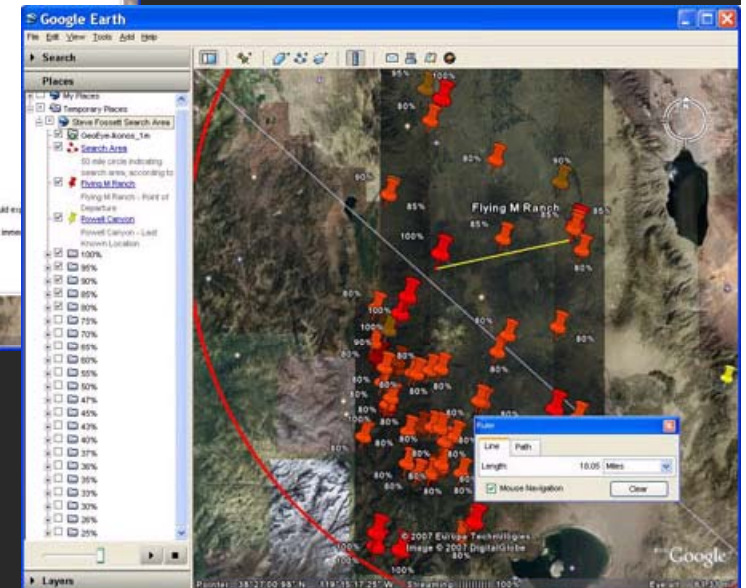
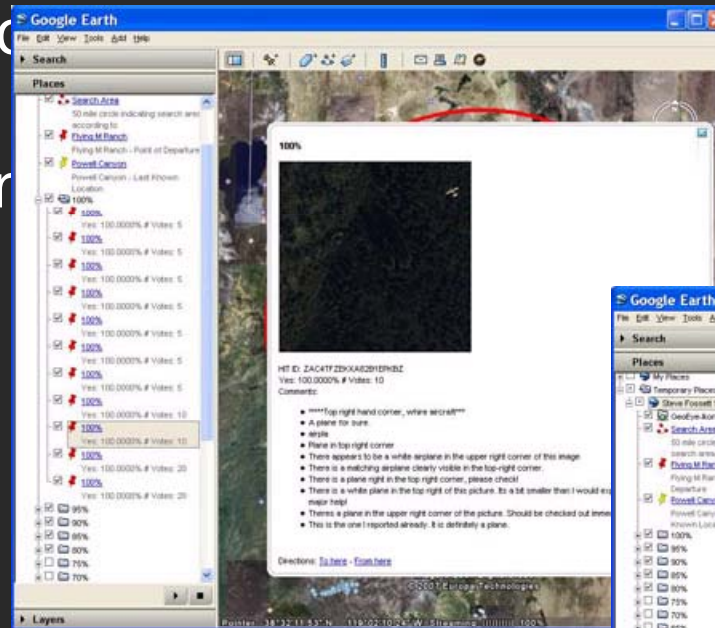
Powershifts



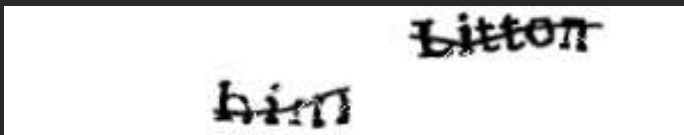
Crowdsourcing

Object Recognition
Fakes
Template matching

Amazon Mechanical
Steve Fossett search



ReCAPTCHA=OCR



<http://www.wired.com/wired/archive/14.06>

Visual Social Computing

- Image-based commerce
 - By the people, for the people, of the people
- Next Trend in India ?
- Business Model ?

Cameras in Developing Countries



Community news program run by village women

http://news.bbc.co.uk/2/hi/south_asia/714

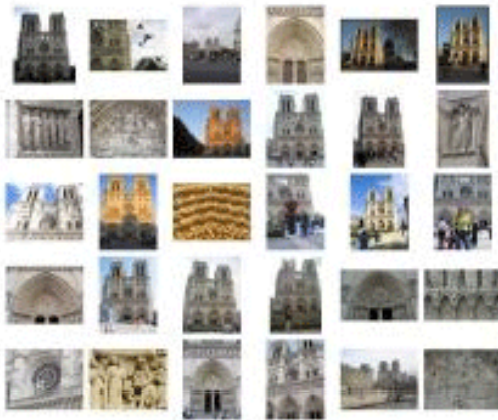
User Generated Content Visualization



Photo Synth

Microsoft

Exploring photo collections in 3D



(a)



(b)



<http://phototour.cs.washington.edu/>

- Google Map overlaid with geo-tagged photos
- Image-based Mashups



Socio-Political Goals: B'Tselem



From website of : Israeli Information Center for Human Rights in the Occupied Territories

Truth in Images



LA Times March '03



From Hany Farid

Developing Countries: CAMForms

- Paper forms with barcodes
- 83-bit 2D codes (including seven bits of error correction)



Formulario
 Direcciones: Este formulario de inspección debe de ingresar el código de barras con el teléfono comenzara a proporcionar le tomar alguna fotografía o hacer una grabación puede ingresar el código de barras con el código también de código del productor.

Seccion 0 Informacion general

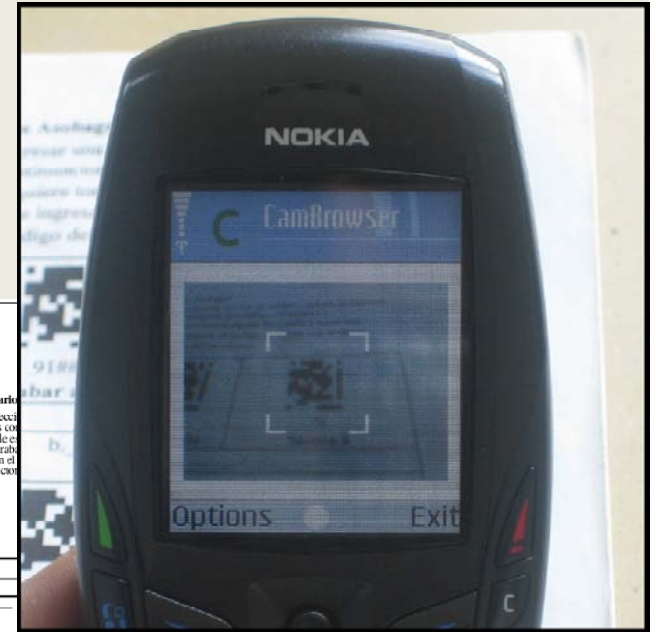
U.1	Código de productor
U.2	Cuántas parcelas tiene? _____

Seccion 1 Semillas y Tratamiento

90#1	91#1	71	Seccion 1
tomar fotografia	grabar audio		
1.1	Hizo 1 Si semillero?	Código de la parcela de origen de semillas	
	2. No	Estado de la parcela	1. Organica 2. Natural 3. Conversion 4. Convencional
1.2	Cantidad de semillas en libras:	Producto que use para desinfectar:	1. Plantas 2. Ceriza 3. Quimico 4. Agua Caliente
1.3	Que sustrato 1. Mat. uso para el Organica semillero?	Producto que uso para desinfectar:	1. Plantas 2. Tierra 3. Arena 3. Quimico
Recomendaciones raras/otras:		Cantidad o dosis:	

Seccion 2 Fuente de plántones y

90#2	91#2	72	Seccion 2
tomar fotografia	grabar audio		
2.1	Control 1. Si almuerzo de café? 2. No	Estatus	1. Organica 2. Natural 3. Conversion 4. Convencional
		Código de la parcela de origen:	
2.2	Sembró 1. Si algunos frutales dentro de la parcela?	Cuales?	1. Citrico 2. Banano 3. Conversion 4. Convencional
		Estatus	1. Organica 2. Natural 3. Conversion 4. Convencional



Visual Social Computing

How will the next billion cameras change the social culture ?

How can we augment the camera to support best 'image search' ?

How will camera improve trust and social stability ?

How will movie-making, news reporting change ?

Next model for image-based commerce ?

Ramesh Raskar

Associate Professor, MIT Media Lab

<http://raskar.info>

Extra Slides