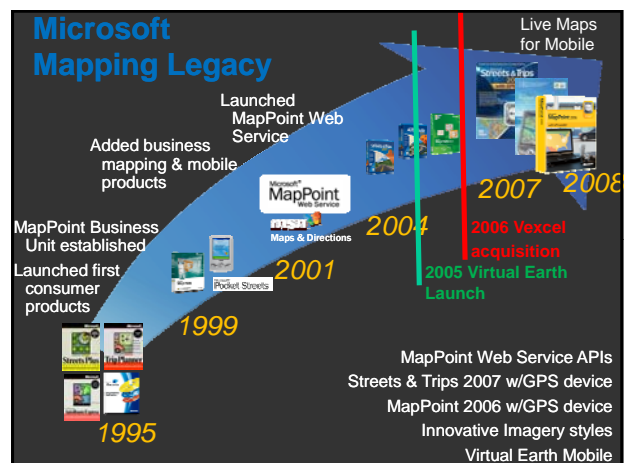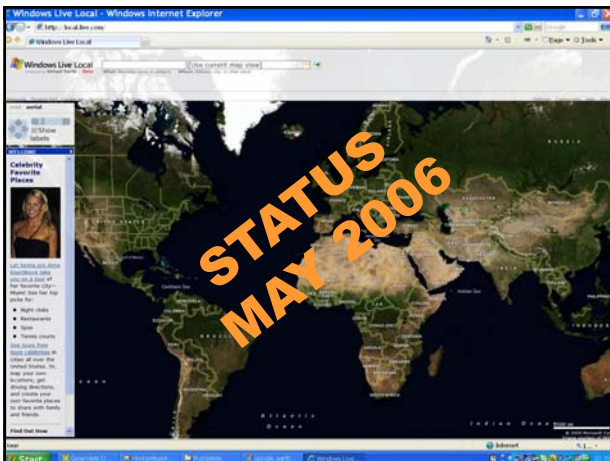# THE FIRST DIGITAL DECENNIUM
1998-2008

THE INTERNET NOW IS LOCATION AWARE

Every Place, Anywhere, Anytime

---

maps.live.com

---

maps.live.com

Microsoft Mapping Legacy

Live Maps for Mobile

Launched MapPoint Web Service

Added business mapping & mobile products

MapPoint Business Unit established

Launched first consumer products

2008
2007
2004
2001
1999
1995

2006 Vexcel acquisition

2005 Virtual Earth Launch

MapPoint Web Service APIs
Streets & Trips 2007 w/GPS device
MapPoint 2006 w/GPS device
Innovative Imagery styles
Virtual Earth Mobile
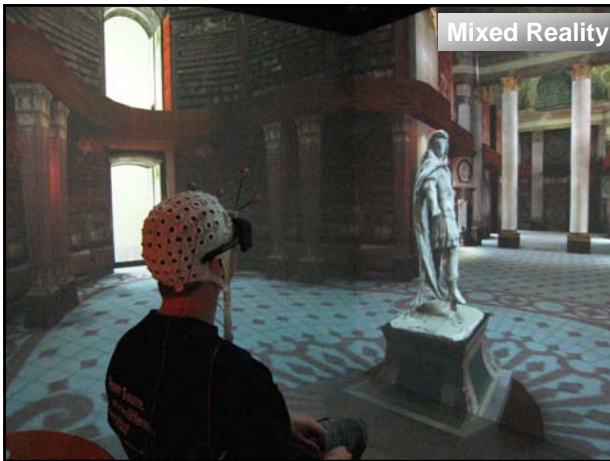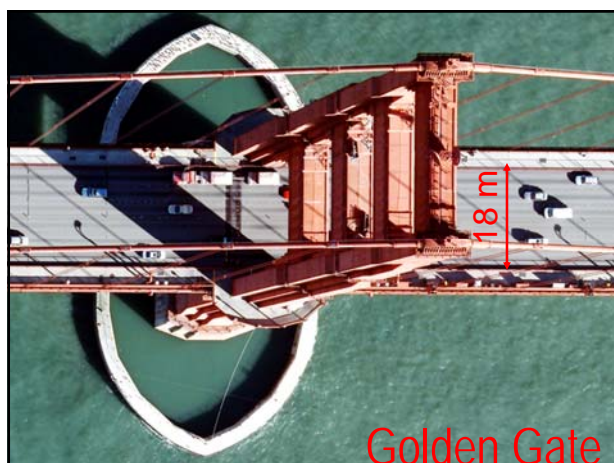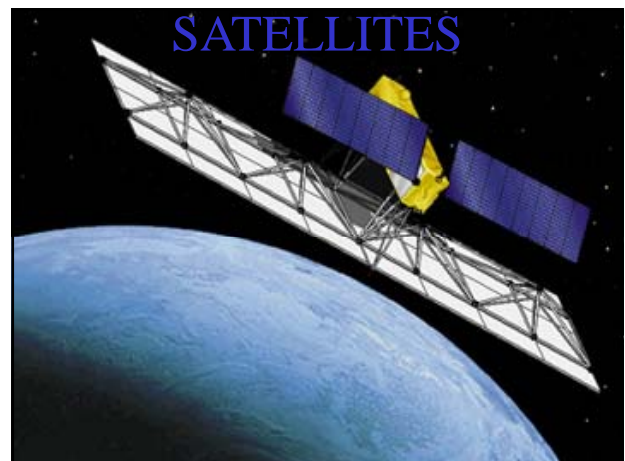
1

STATUS MAY 2006

VISIGRAPP 2009
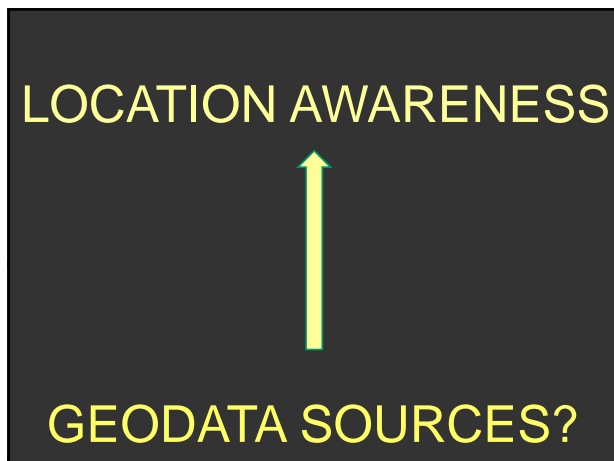
3D-MODELS OF THE HUMAN HABITAT FOR THE INTERNET

Franz Leberl
Graz University of Technology
Institute for Computer Graphics and Vision

1994

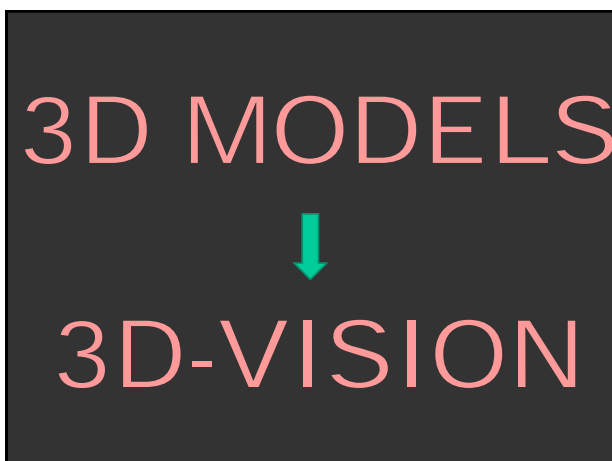Semi-Manually

1998

Telecom Application of Building Data

Intervisibility

AUTOMATICALLY DERIVED 3D MODEL OF GRAZ, AUSTRIA, 2007

Mixed Reality

Killer Application?
Advertisement

Yellow Pages & Local Advertisement US$ 60 Billion/Year

Validation by Enterprise Customers
Extensive Government Agency Customer Base

Validation by Enterprise Customers
Extensive Corporate Customer Base

LOCATION AWARENESS

GEODATA SOURCES?

SATELLITES

Kiev

100 m

New Zealand Aerial Mapping
Rockwell 690 Turbo Commander

ZK-PVB

18 m

Golden Gate

SATELLITES

?

New Zealand Aerial Mapping
Rockwell 690 Turbo Commander

YES

ZK-PVB

GeoEye-1 Launch
50 cm Pixel

THE EARTH'S LAND MASS

The World in 15 cm per Pixel

THE EARTH'S LAND MASS

Sq. km 148 million

THE EARTH'S LAND MASS

The World in 15 cm per Pixel
~ 20 Peta Bytes, 2-D

Kilo
Mega
Giga
Tera
Peta
Exa
Zetta
Yotta

THE EARTH'S LAND MASS

The World in 15 cm per Pixel
~ 20 Peta Bytes, 2-D

Kilo
Mega
Giga
Tera
→ Peta
Exa
Zetta
Yotta

Denver

WE WANT 3D

NOVEMBER 2006
3D Introduced

© 2006 Microsoft Corp

APRIL 2008
All Buildings
Refined Textures
Vegetation

PERSPECTIVES

Search
Navigation
Games
e-Commerce
Smart Phones
Mixed Reality
Internet of Things
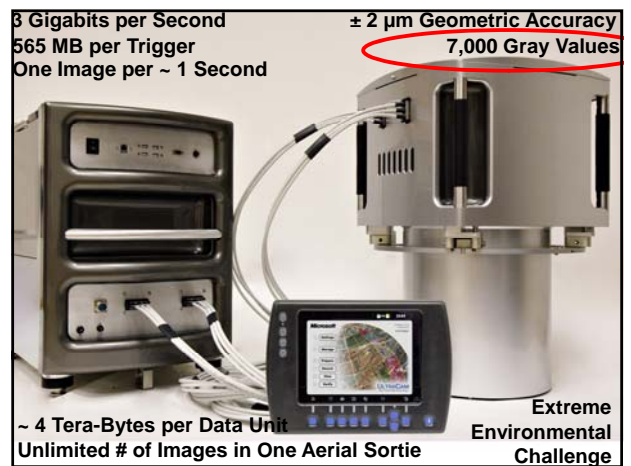**Chips on Body**

………

3D MODELS

⬇

3D-VISION

DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
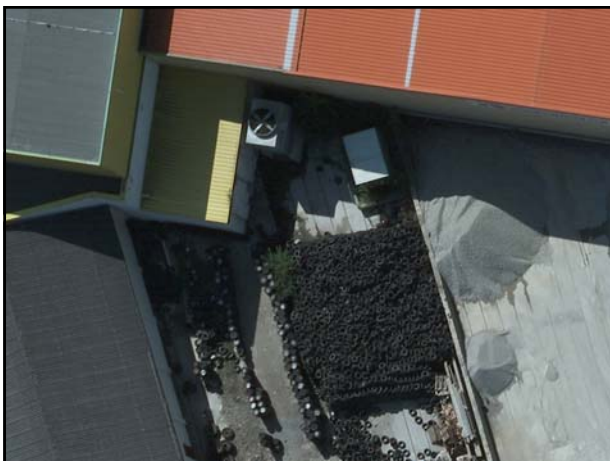DENSE MATCHING
SUPERIOR GEOMETRY
LIMITLESS DETAIL

DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
DENSE MATCHING
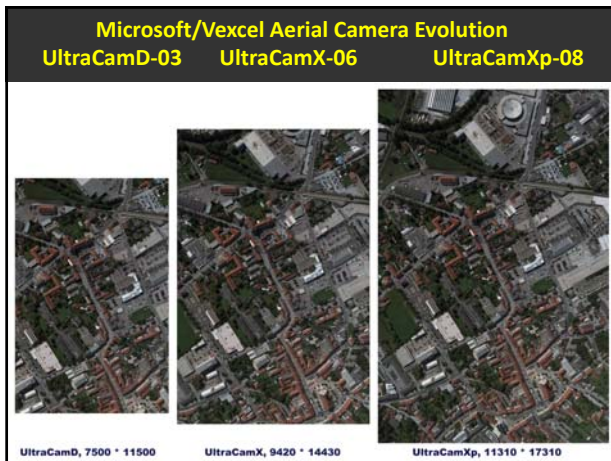SUPERIOR GEOMETRY
LIMITLESS DETAIL

UltraCAM$_X$

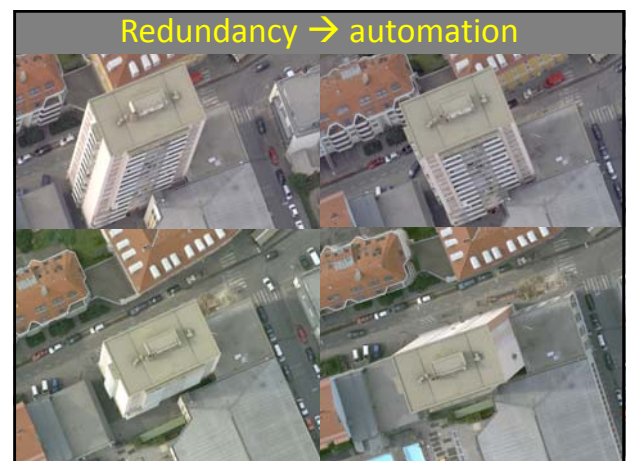**MICROSOFT DUE DILIGENCE**

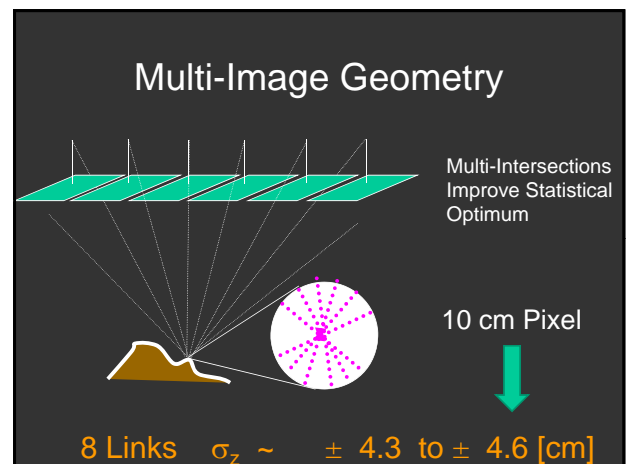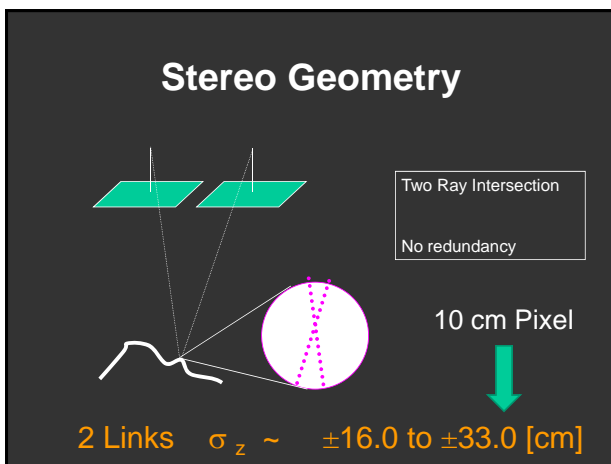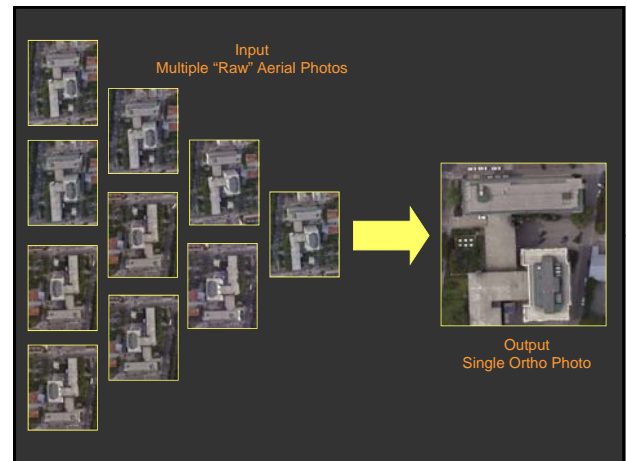"What is so hard about
large format digital aerial cameras?"

Bill Gates, Jan 2006

3 Gigabits per Second   ± 2 µm Geometric Accuracy
565 MB per Trigger   7,000 Gray Values
One Image per ~ 1 Second

~ 4 Tera-Bytes per Data Unit

Extreme Environmental Challenge

Unlimited # of Images in One Aerial Sortie

Area (Pan):

Min   60
Max   7920

7860 Grey Levels

12.94 bit

Microsoft/Vexcel Aerial Camera Evolution
UltraCamD-03   UltraCamX-06   UltraCamXp-08

UltraCamD, 7500 * 11500   UltraCamX, 9420 * 14430   UltraCamXp, 11310 * 17310

11,310 Pxl.

17,310 Pxl.

THE MOST SUCCESSFUL AERIAL CAMERA

cm

GERMANY

D-ELYK

Weser Luftbild

CHINA

AUSTRIA

VEXCEL

DIAMOND AIR

AIRBORNE SENSING

Maiden Flight Fall 2006

DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
DENSE MATCHING
SUPERIOR GEOMETRY
LIMITLESS DETAIL

Frame 175 Frame 176 Frame 177 Frame 178 Frame 179

Frame 218 Frame 219 Frame 220 Frame 221 Frame 222

Input
Multiple "Raw" Aerial Photos

Output
Single Ortho Photo

Stereo Geometry

Two Ray Intersection

No redundancy

10 cm Pixel

2 Links σ_z ~ ±16.0 to ±33.0 [cm]

Multi-Image Geometry

Multi-Intersections
Improve Statistical
Optimum

10 cm Pixel

8 Links σ_z ~ ± 4.3 to ± 4.6 [cm]

Redundancy → accuracy

Redundancy → automation

Redundancy → occlusion avoidance

Redundancy → outlier detection

THE EARTH'S LAND MASS

The World in 15 cm per Pixel
towards 200 Peta Bytes, 2-D

Kilo
Mega
Giga
Tera
→ **Peta**
Exa
Zetta
Yotta
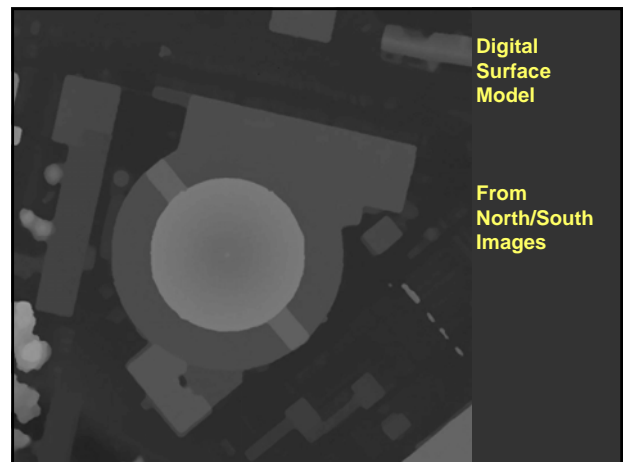
DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
DENSE MATCHING
SUPERIOR GEOMETRY
LIMITLESS DETAIL

- Coarse Match
- Bundle adjustment
  - Several thousand images
  - Few GCPs

GRAZ 3000 PHOTOS
→ 1.5 TBYTES
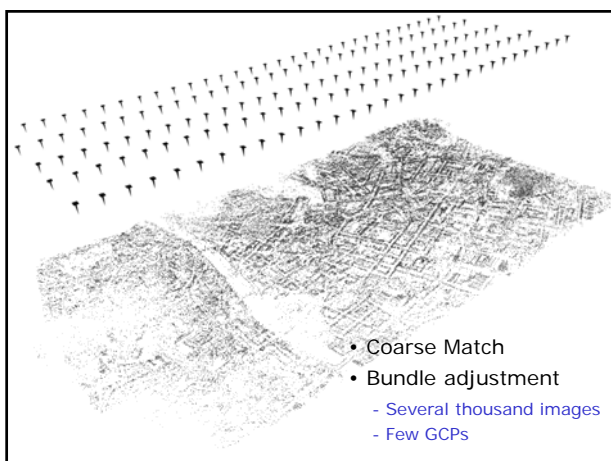
Dragonfly
(Child of Seadragon)

DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
DENSE MATCHING
SUPERIOR GEOMETRY
LIMITLESS DETAIL

Winston-Salem DSM to DEM

Classification

AUTOMATED BUILDING EXTRACTION
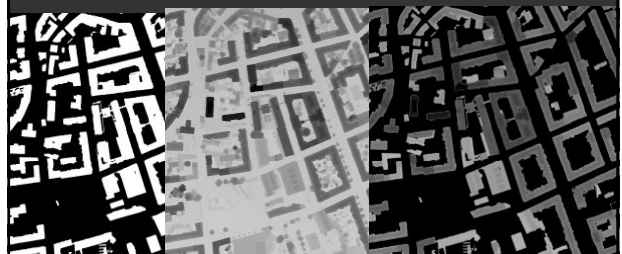
Image classification in combination with dense surface model supports buildings to be extracted

Apartment complex in Atlanta

AUTOMATED BUILDING EXTRACTION
Phototexture from UltraCam images

AUTOMATED BUILDING EXTRACTION
Combined with DEM and Ortho in Virtual Earth

2.5 Dimensional Building, Denver
2.5D has its limitations!

Trees: Multi- vs. Two-Image Stereo,
Multi-Image   2-Image Stereo
No Trees, just Forest

Trees: Multi- vs. Two-Image Stereo
Multi-Image   2-Image Stereo
Individual Trees   No Trees, just Forest

UltraCam Vegetation Modeling, M. Schardt

DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
DENSE MATCHING
SUPERIOR GEOMETRY
LIMITLESS DETAIL

Two Flights

North/South
East/West

Dense
Surface
Model

@ 10 cm Pixel

Digital
Surface
Model

From
North/South
Images
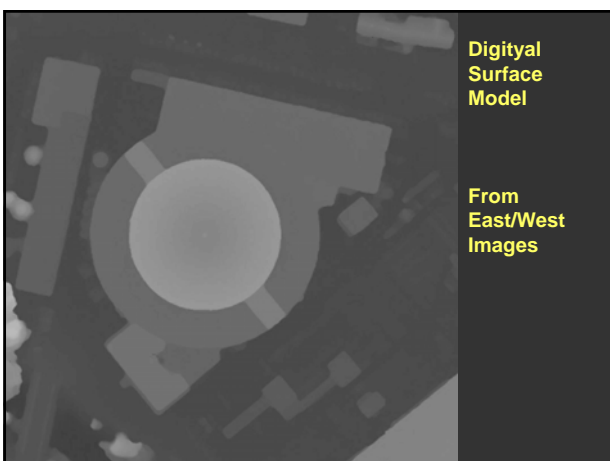
Digityal
Surface
Model

From
East/West
Images
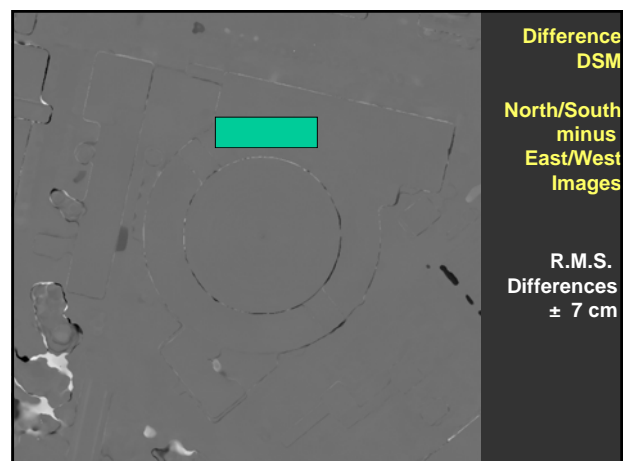
Difference
DSM

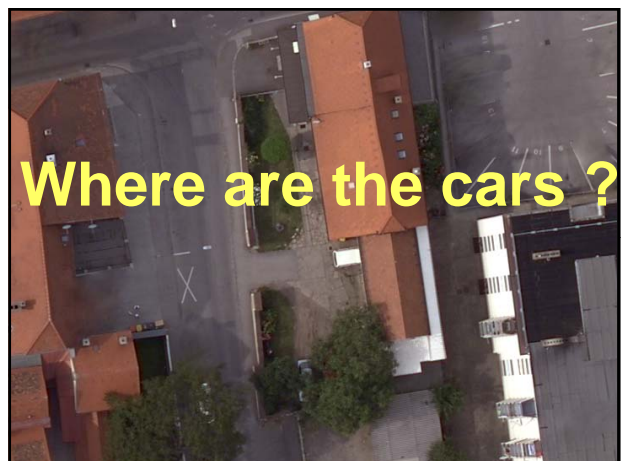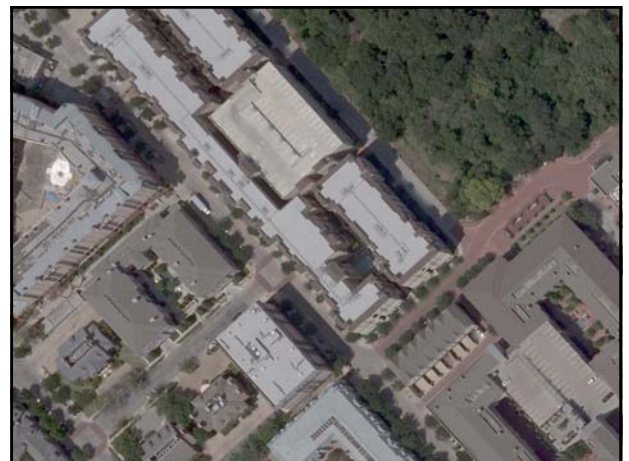North/South
minus
East/West
Images

R.M.S.
Differences
± 7 cm

MEDIOCRE MATCHER

SUPERIOR MATCHER

DIGITAL 3D-V?

EXCELLENT AERIAL IMAGERY
SMART IMAGE COLLECTION
AUTOMATED TRIANGULATION
DENSE MATCHING
SUPERIOR GEOMETRY
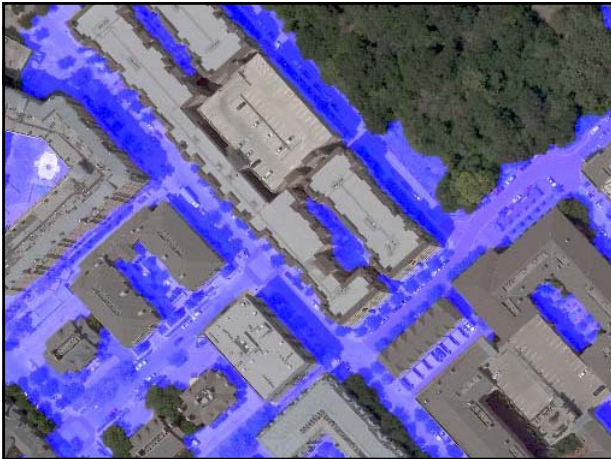LIMITLESS DETAIL
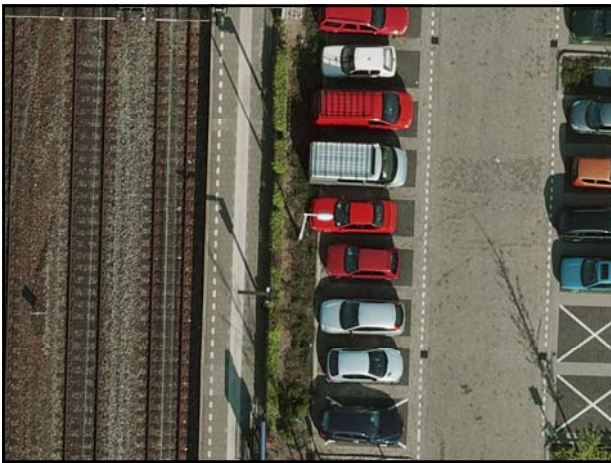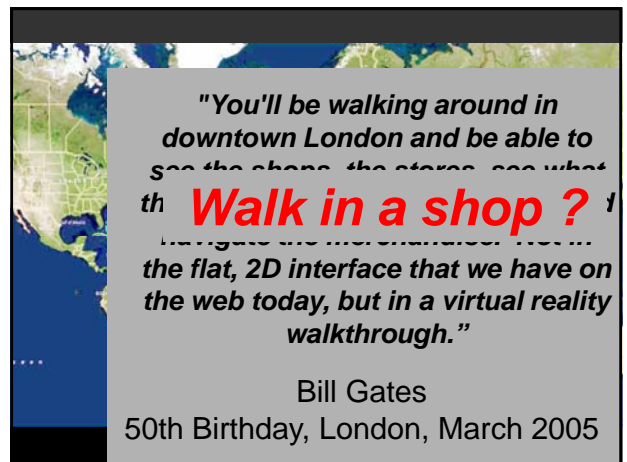
NEW IDEAS
TO SOLVE NEW PROBLEMS

Where are the cars ?

90% Correct

……Substantial
redundancy-inspired progress
yet to be expected

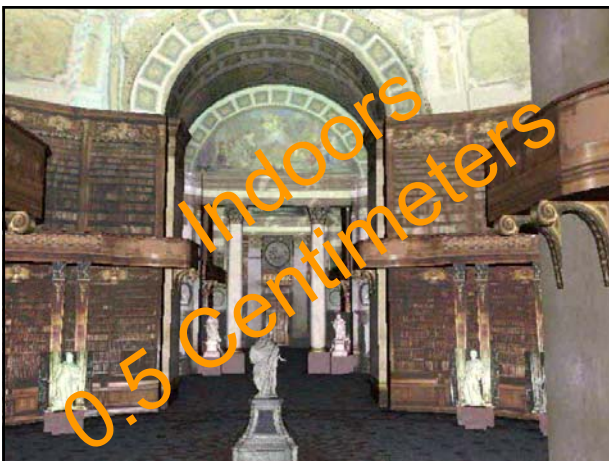THE HUMAN SCALE
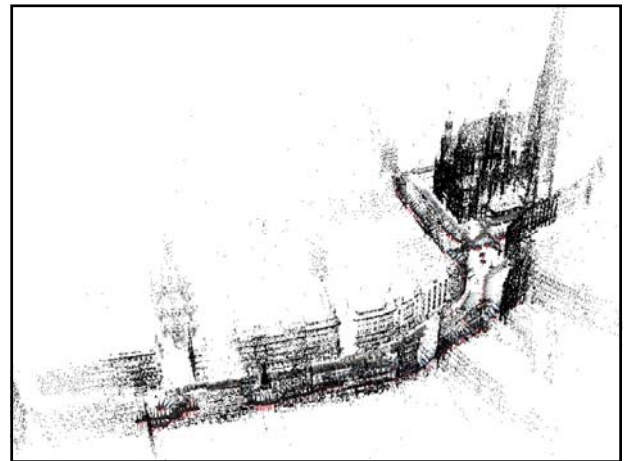

The Virtual Earth Vision

"You'll be walking around in downtown London and be able to see the shops, the stores, see what th **Walk in a shop ?** *navigate the merchandise. Not in the flat, 2D interface that we have on the web today, but in a virtual reality walkthrough."*

Bill Gates
50th Birthday, London, March 2005

STREET SIDE

Streetmapper
Laser Scanning in Graz

Streetside
2 Centimeters

2 Centimeters

Still Images

Indoors
0.5 Centimeters

Mapping Objects
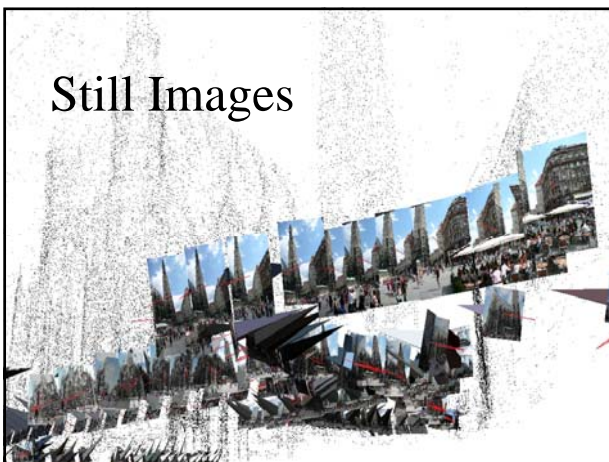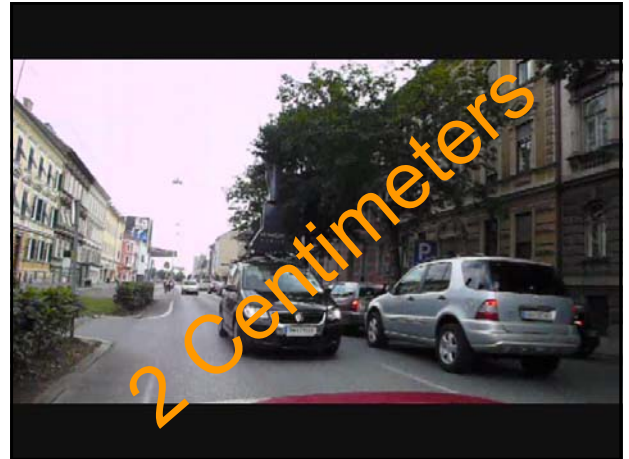
THE EARTH'S HUMAN HABITAT

The World in 15 cm per Pixel

Street Side in 2 cm
Interior in 0.5 cm

…and with 10 x redundancy

Towards 1 Exabyte

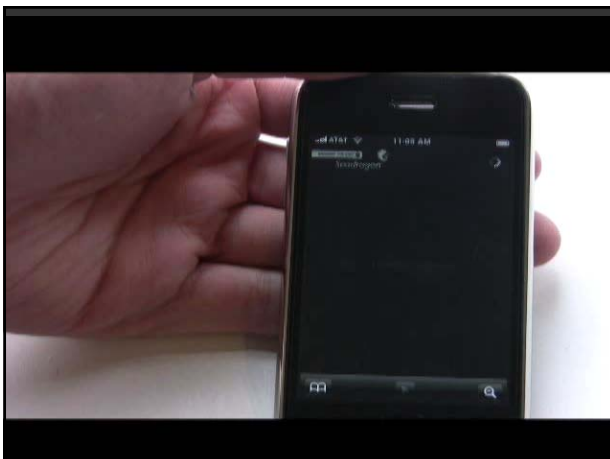

ESP: Dynamic Seasonal Environments

FALL

HARD WINTER

DATA EXCESS?

Photosynth TECH PREVIEW

USER INVOLVEMENT

Available since 20 August 08

THE FUTURE?

1977

Karl-Franzens University Graz

1977 JOINT
AVAILABLE
DISK SPACE

80 MEGABYTES

€ 100,000

Graz University of Technology

2007

OUR (THEN) UNIVERSITY
VICE-PRESIDENT THEURL

2007
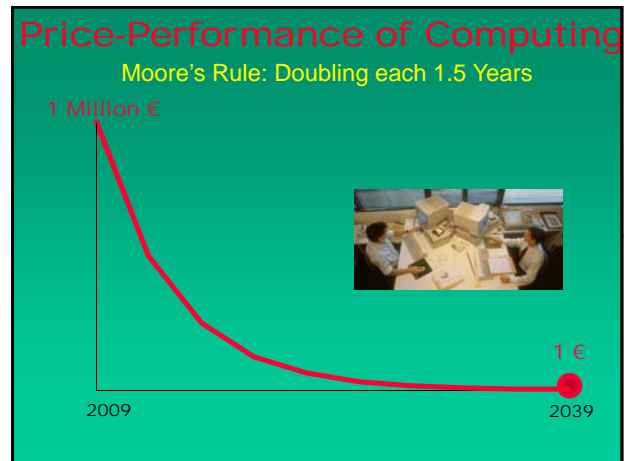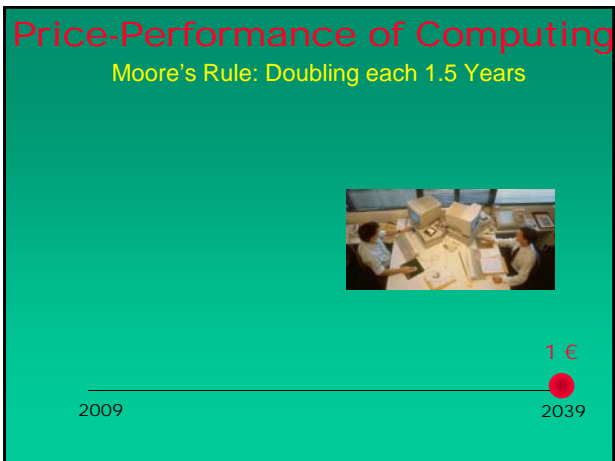VICE-PRESIDENT THEURL
Retired with 4 GB of data

BUYS DISK SPACE
500 GIGABYTE

€ 100

1977-2007
Improvement
12,500,000

DRIVERS FOR INNOVATIONS?

2009-2039

1 MILLION?

"HONEY,
PICK UP A 6-PACK OF
COMPUTERS ON THE
WAY HOME"

Mark Weiser, 1996