IEEE/ACM International Symposium on Mixed and Augmented Reality (ISMAR) 2009

Augmenting Aerial Earth Maps with Dynamic Information

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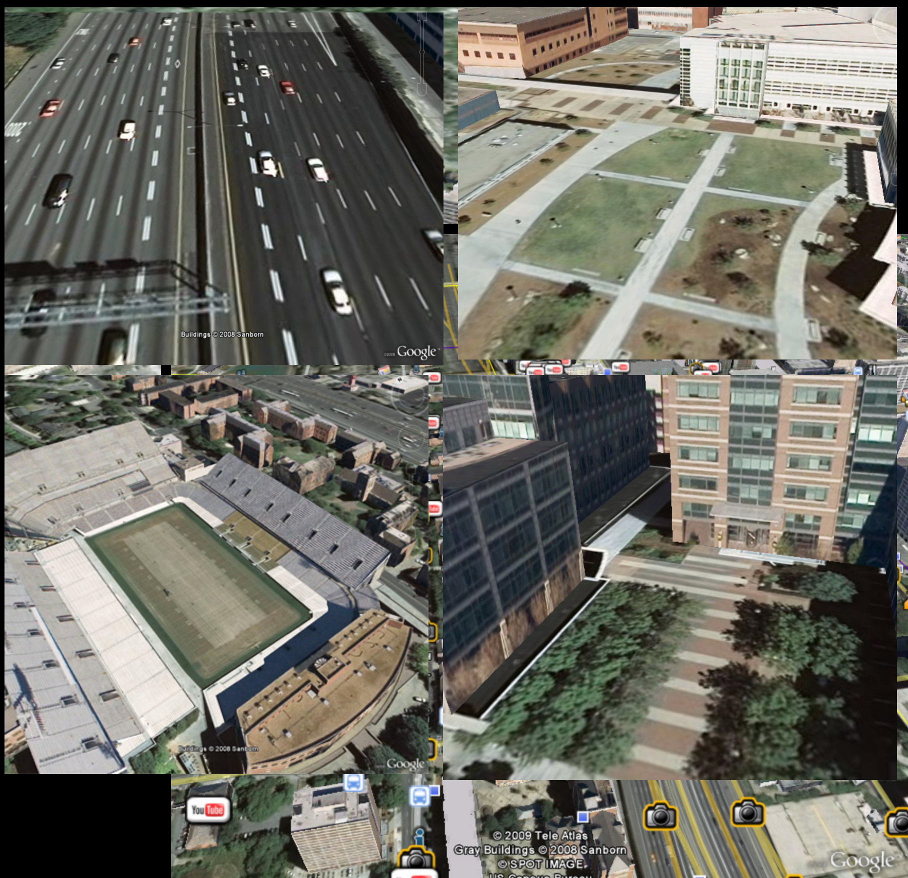
Motivation



Virtual Earth Maps (Google Earth)

\+

- Nice quality of 3D buildings
- Realistic Aerial Textures
- Fly around anywhere

- Annotated information
- Pictures, Videos

–

- Everything is static
- No dynamic information

Motivation

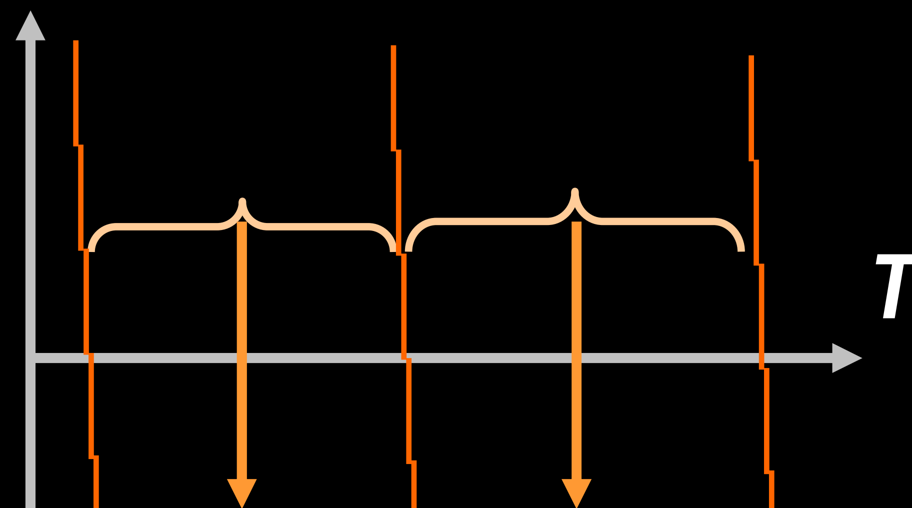
Our Goal is :

Putting Dynamic Information onto Static Earth Map

Then, making it come ALIVE…

Overview

- Resources in current Virtual Earth..



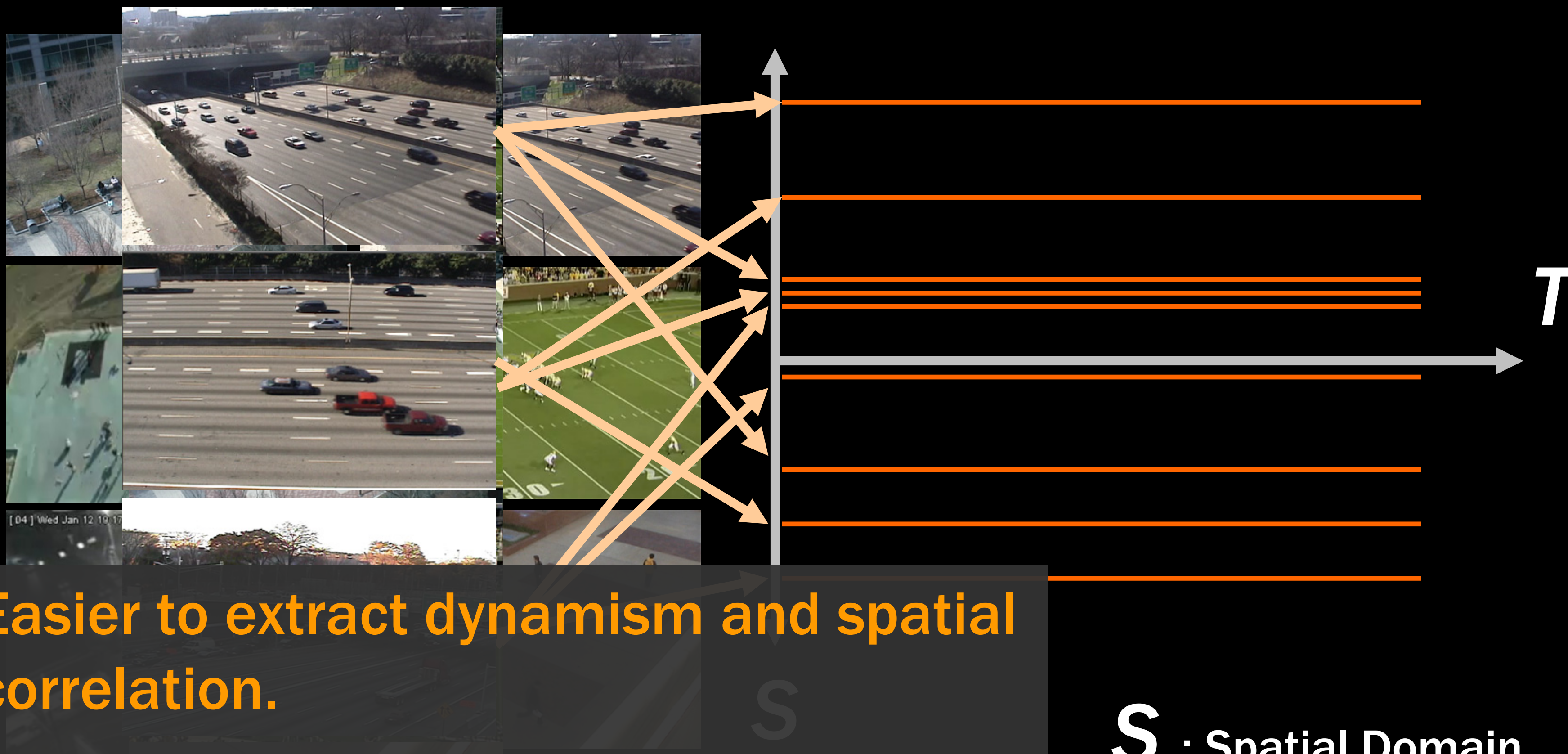
Update interval

: almost 4~6 months

Hard to interpolate temporal information !

Overview

- What if we make use of distributed videos* ?



Easier to extract dynamism and spatial correlation.

But methods should vary!

S : Spatial Domain
T : Time Domain

* Public cameras, sport footage, individual videos

Overview

- Four different Scenarios

Traffic Visualization

Sports Visualization

Sky/Clouds Visualization

Pedestrian Visualization

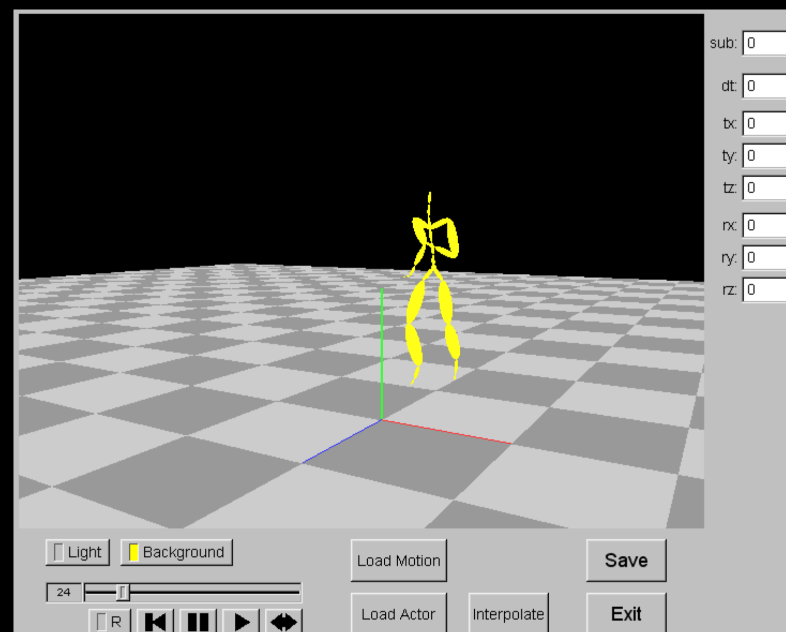
- Sparsity of Camera
- Motion Complexity

Scenario 1 : Pedestrian

Direct Mapping : Single view, Limited motion

Tracking
(Velocity, Pos)

→ Animating pedestrian using Motion Capture Data*



*Carnegie Mellon MoCap database

Scenario 1 : Pedestrian

Direct Mapping : Single view, Limited motion

Tracking
(Velocity, Pos)

Animating pedestrian using
Motion Capture Data*

Mapping using
Homography

*Carnegie Mellon MoCap database

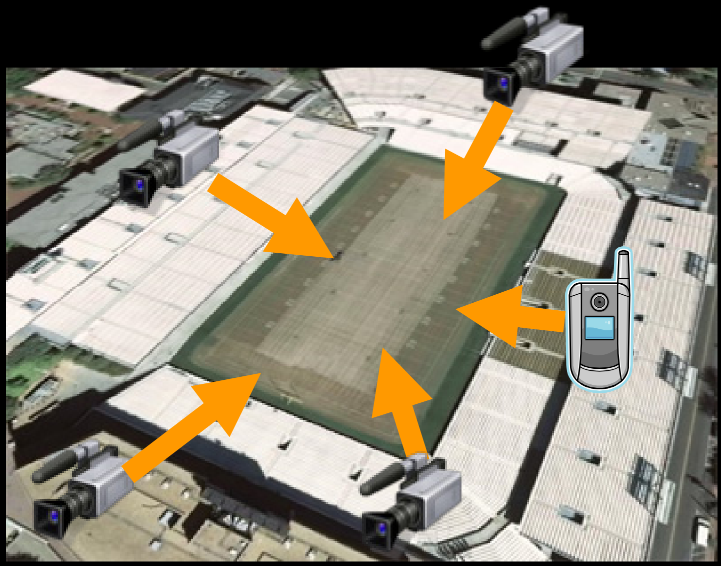
Scenario 2 : Sports Visualization

Dynamic sports scenes :

Complex motion*

Overlapping cameras

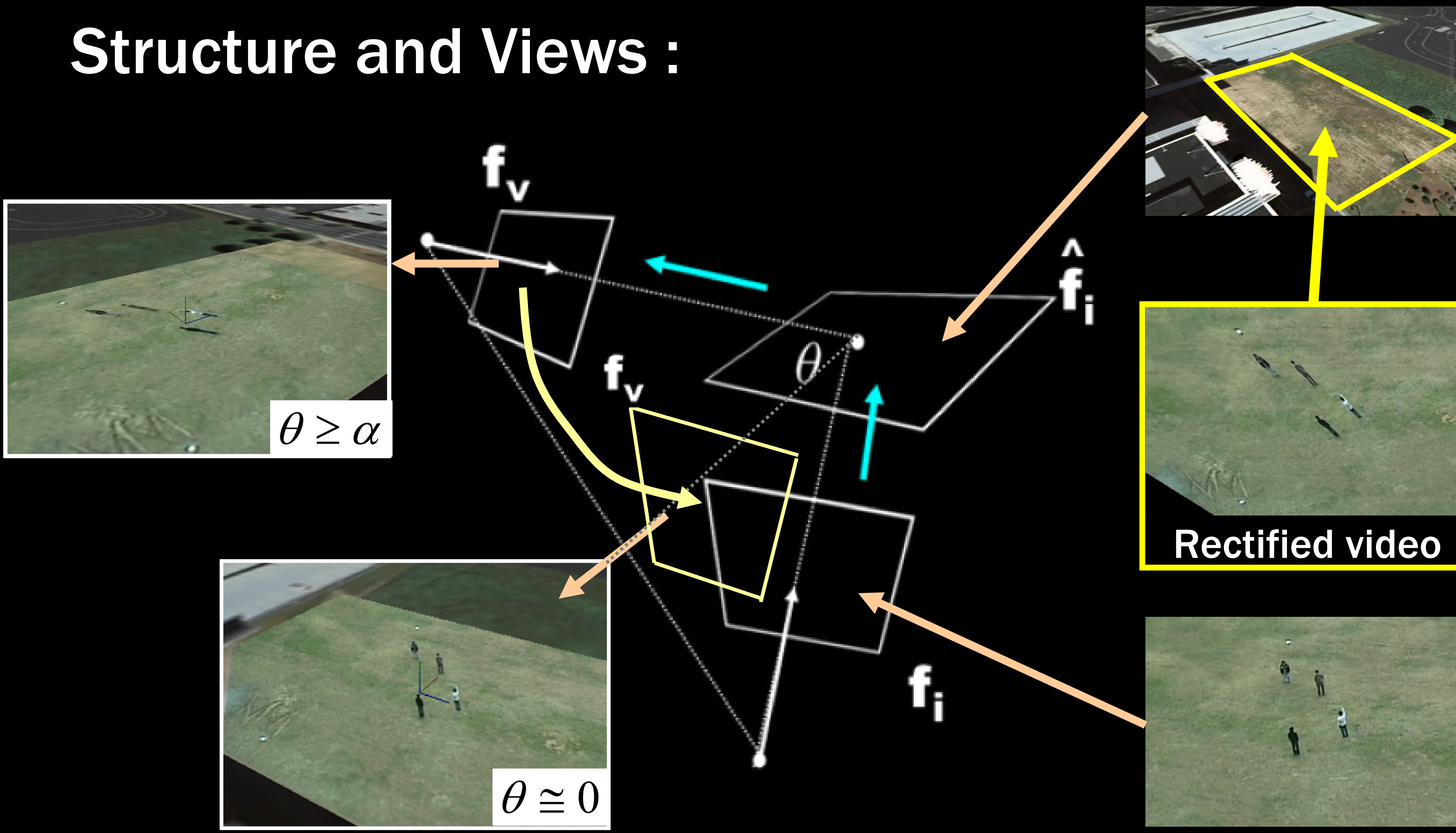
→ View Synthesis



*Efros et al 2003

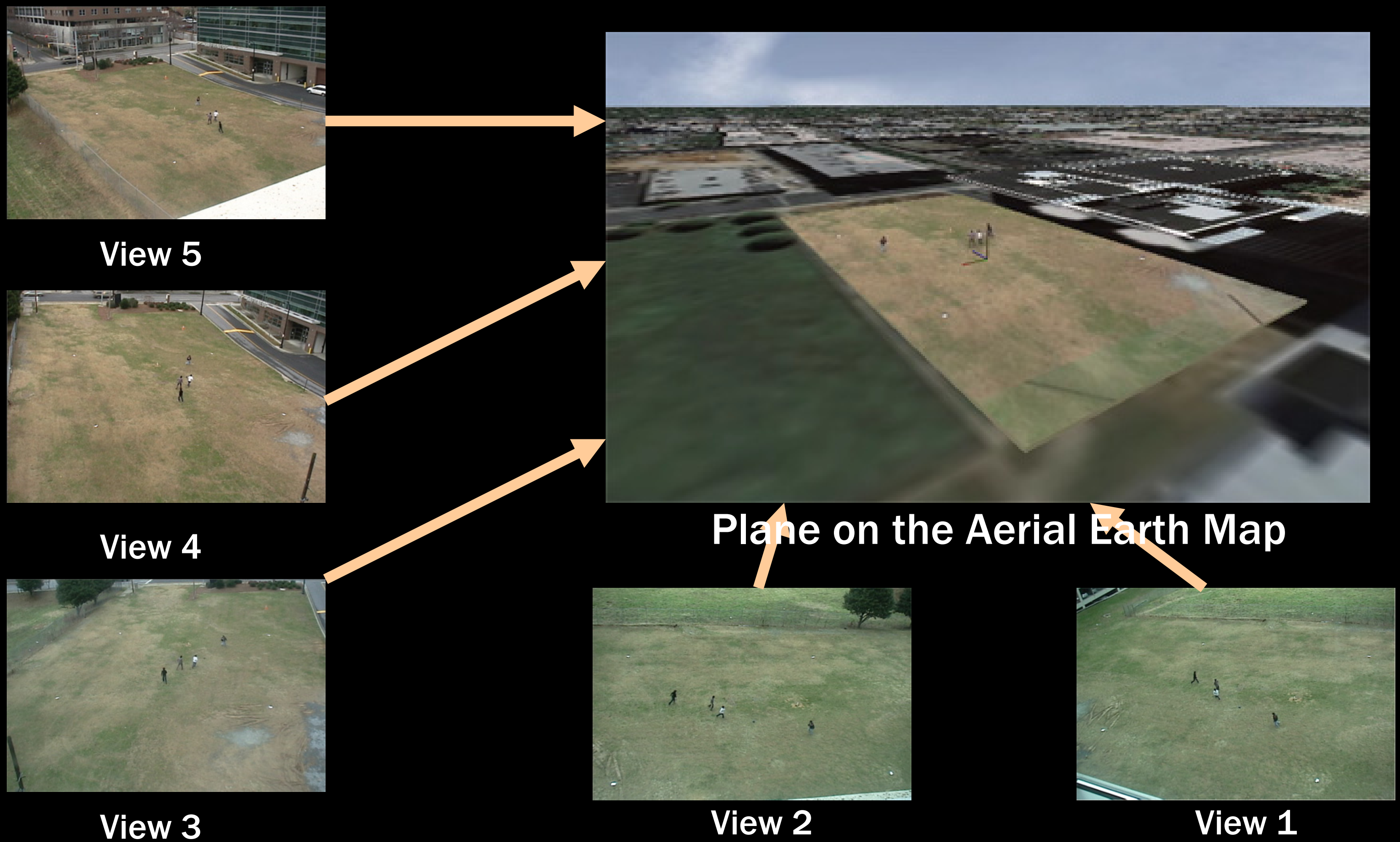
Scenario 2 : Sports Visualization

Structure and Views :



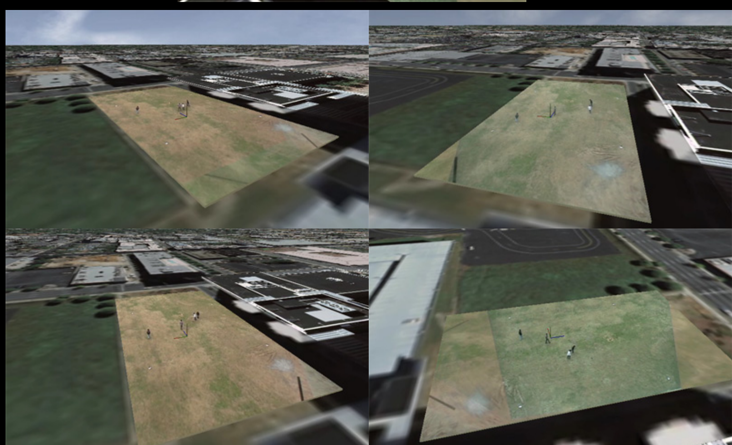
Scenario 2 : Sports Visualization

- Five views and their optimal virtual views



Scenario 2 : Sports Visualization

- In an arbitrary view → Globally blended views



$$\mathbf{p}_v = f(\omega_i)\mathbf{p}_i + g(\omega_i)\mathbf{p}_{i+1} + \omega_{\mathrm{bkg}}\mathbf{p}_{\mathrm{bkg}}$$

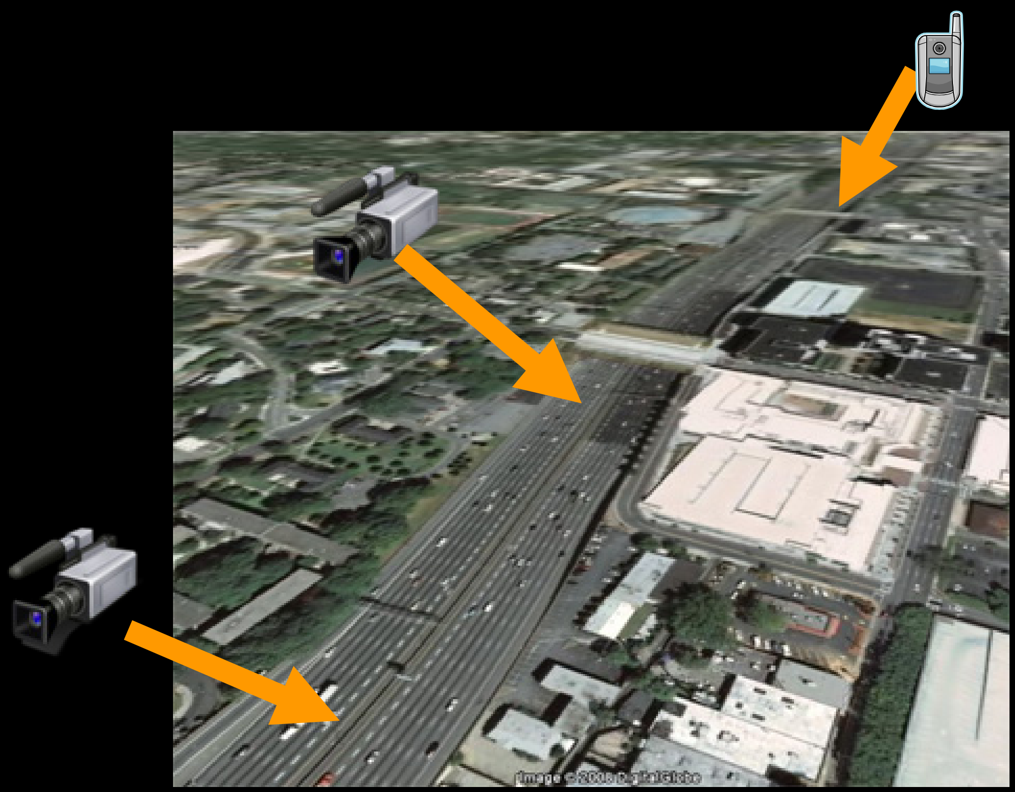
Scenario 3 : Traffic Visualization

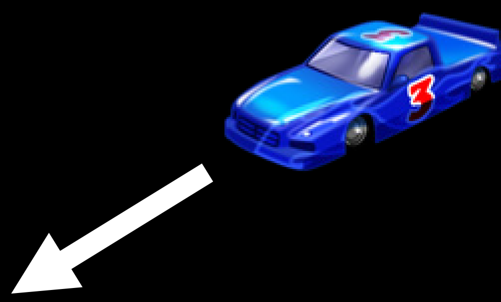
Traffic cameras

Sparsely distributed cameras,

Simple motion

(Follows the road)





Scenario 3 : Traffic Visualization

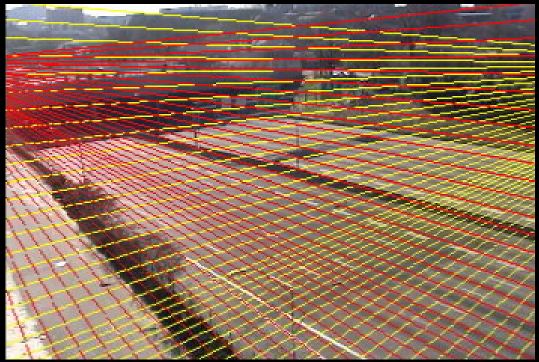
Extraction :

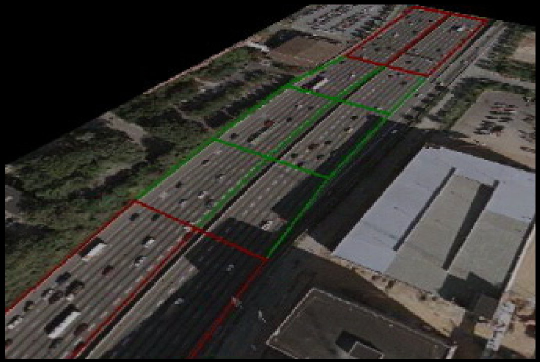
(1) Tracking Cars*

(2) Registration

Vanishing Pts**

Structure for plane patch



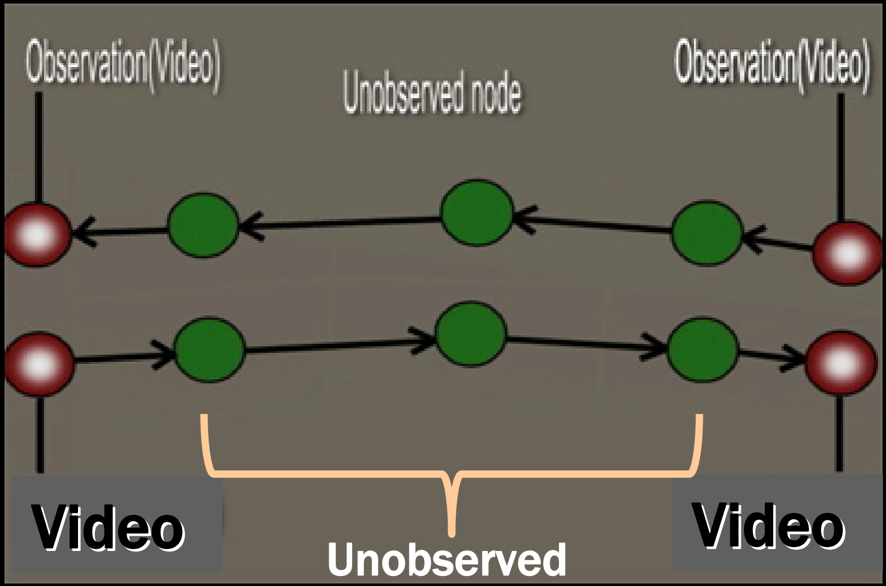


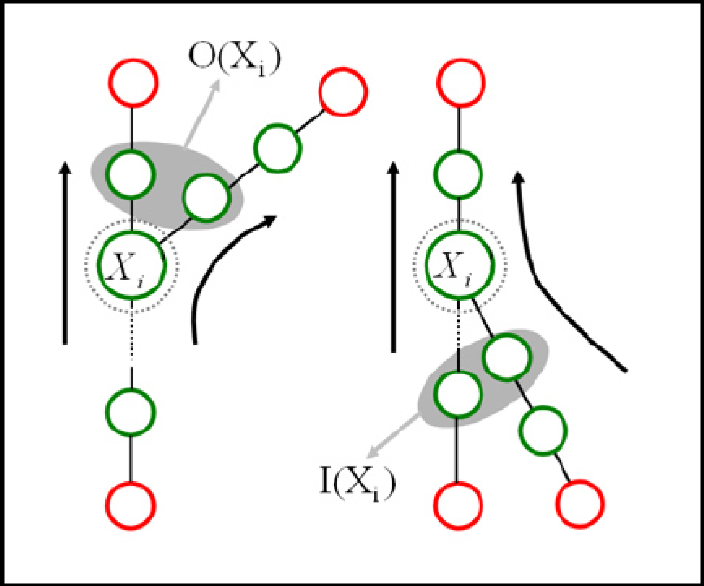
*Veenman01, Shi/Tommassi94, **Kosecka02

Scenario 3 : Traffic Visualization

Construct nodes :

Estimate velocity & flow of the unobserved node from observed node





Observed nodes

Unobserved nodes

Observed nodes

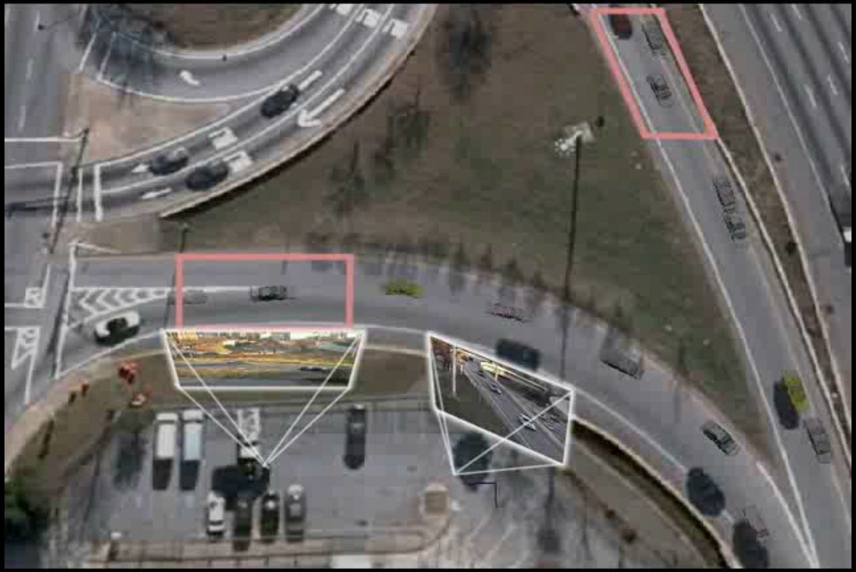
Scenario 3 : Traffic Visualization

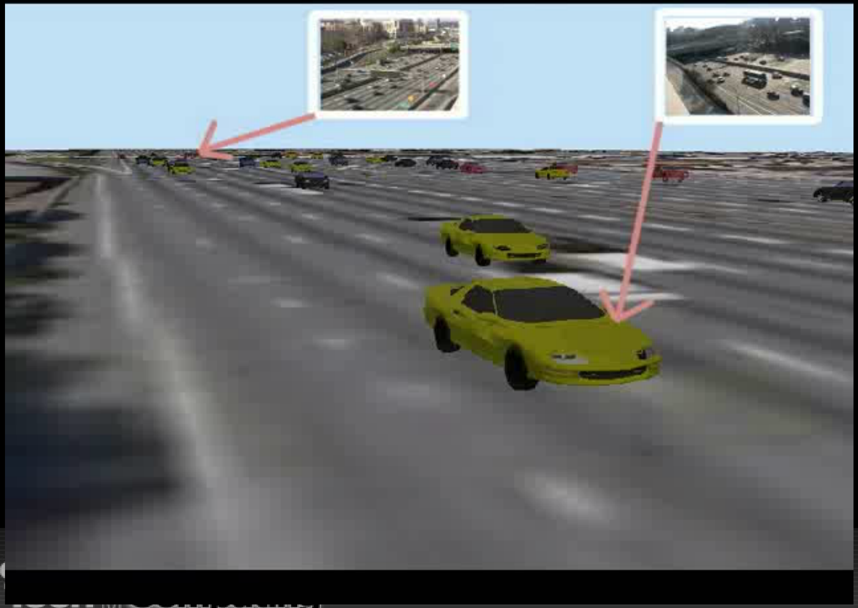
Simulating cars with the velocity of each node and behavioral models (flock, steering)*

$$\mathbf{V}_{i,k} = \alpha \mathbf{V}_i^{flock} + \beta \mathbf{V}_i^{steer} + \boxed{\gamma \mathbf{V}_k^{node}}, \quad \mathbf{V}_k^{node} = \sum_{j=0}^{n} \omega_j (\mathbf{V}_j^{node})$$

* Reynolds (SIGGRAPH87,GDC99)

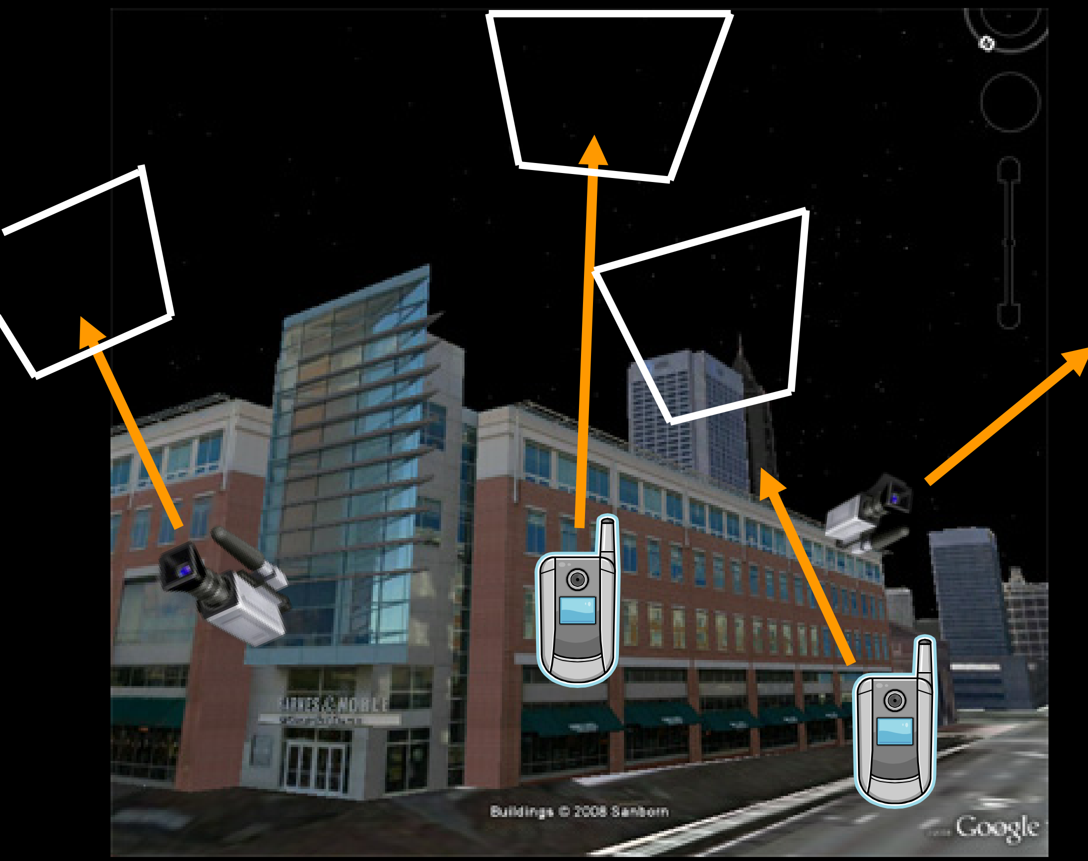
Scenario 3 : Traffic Visualization - Results





Scenario 4 : Sky and Clouds

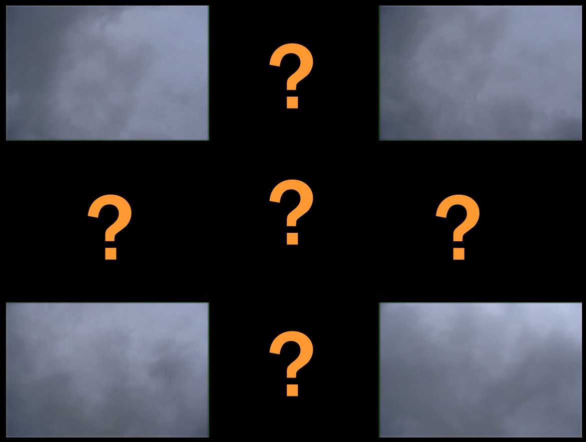
Sparse cameras



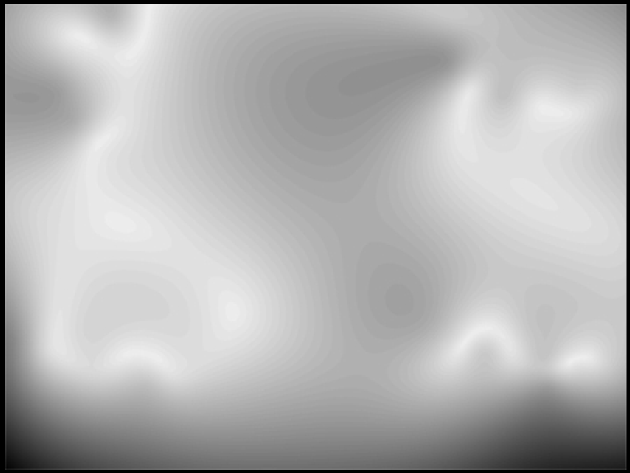
Complex motion

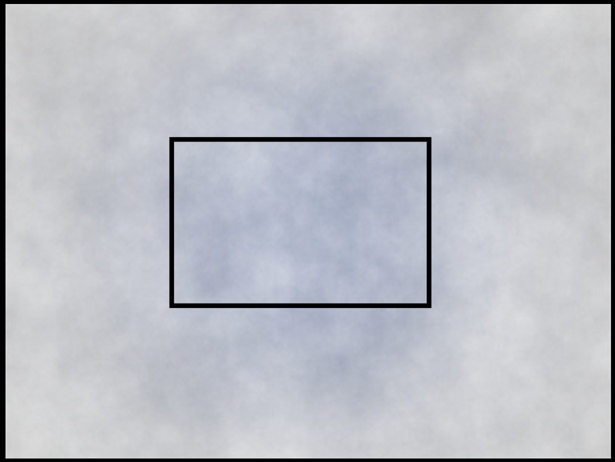
(Particle Model)

Scenario 4 : Sky and Clouds



Interpolating motion/texture using Radial Basis Function (RBF)

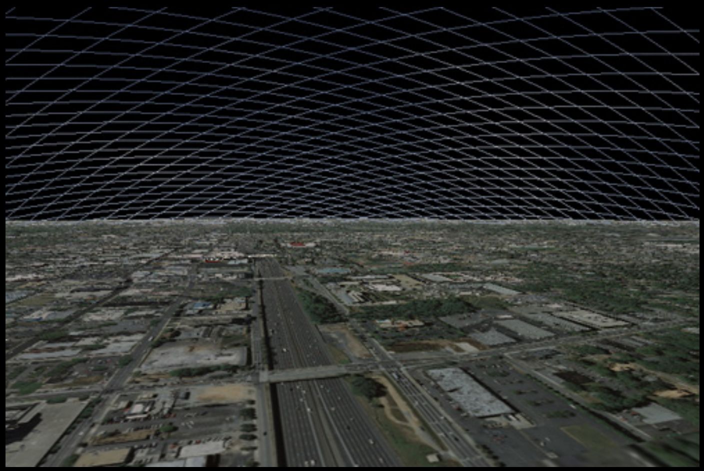


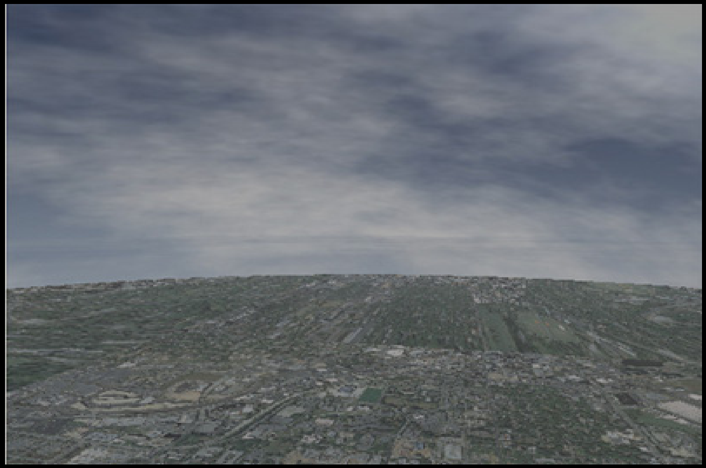


Data-driven, procedurally rendered clouds

Scenario 4 : Sky and Clouds

- Projecting clouds maps onto sky dome





Results

- Putting it all together

  (Q9300 Quad-core 2.53GHz : ~ 10-15 fps)

Contributions

Novel framework to visualize dynamism

- Global view-blending : sports scene
- Parameterized behavioral model : traffic
- Vision driven procedural rendering of clouds : sky and clouds

Possible Applications

- Augmented online map services
- Interactive sports broadcasting
- Virtual environment or game has a metaphor of the real world (Second-life)
- New marketing opportunities

Conclusion

Limitations:

- Algorithmic Trade-offs
- High-level traffic events (e.g., accidents, traffic light)
- Direct Mapping only covers given FOV

Future work:

- Aim to overcome above limitations
- Apply to other situations (scenarios)

Thank you!

More information :

http://www.cc.gatech.edu/cpl/projects/augearth/

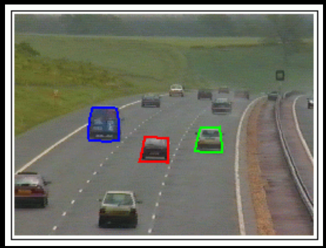
Related work

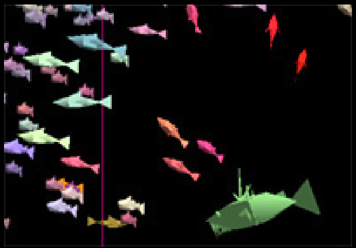
AVE System (SentinelAVE LLC.)

Skyline Globe (Skyline Soft)

Video Flashlight

GooPS system





And lots of literatures in Vision, Graphics and animation field

(To refer at the end of presentation)

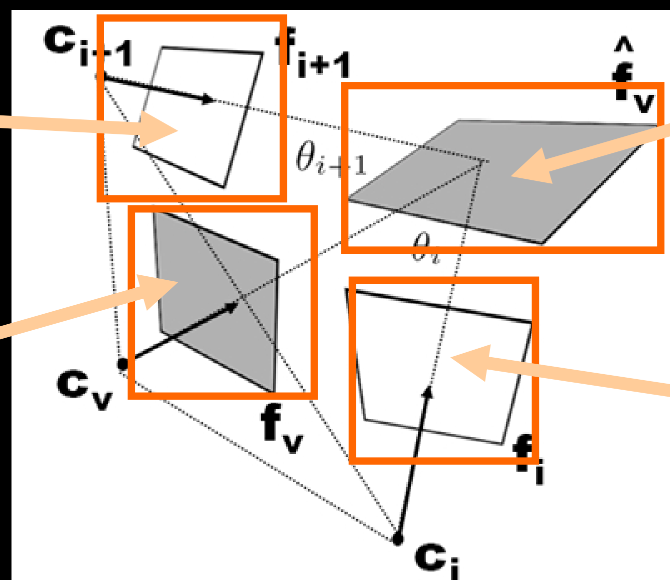
Scenario 2 : Sports Visualization

Globally interpolating views

(1) Select most closest views

(2) Weighted sum of each view with backgrounds

(3) Back-projects it



$$p_v = f(\omega_i)\, p_i + g(\omega_i)\, p_{i+1} + \omega_{bkg}\, p_{bkg}$$

Conclusion

Privacy Issues

- Detection and limited category recognition (Objects are symbolized)
- Sports visualization : Copyright
- Friendly games from individual videos : Publish in public or private (Youtube)