

# 3D Reconstruction from Video Streams Collected by Autonomous Vehicles







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19th Summer School on Image Processing  
Szeged - Hungary

# Outline

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- Unauthorized Bio 
- 3D Reconstruction and Autonomous Navigation 
- VeRoNa Simulator 
- VALEN 
- BRUMA 
- Near Future 

**Unauthorized Bio**

# Unauthorized Bio

Unauthorized Bio ● ● ●

3D Reconstruction and Autonomous Navigation ● ●



# Unauthorized Bio

Unauthorized Bio ● ● ●

3D Reconstruction and Autonomous Navigation ● ●



# Unauthorized Bio

Unauthorized Bio ●●●

3D Reconstruction and Autonomous Navigation ●●



# **3D Reconstruction and Autonomous Navigation**



# 3D Reconstruction and Autonomous Navigation

3D Reconstruction and Autonomous Navigation ● ●

VeRoNa Simulator ● ●

- 3D Reconstruction
  - Real-time Structure from Motion
  - No prior knowledge
  - Few assumptions
  - Precision *vs.* Time consumption

**BRUMA**

**VALEN**



# 3D Reconstruction and Autonomous Navigation

3D Reconstruction and Autonomous Navigation ●●

VeRoNa Simulator ●●

- Autonomous Navigation
  - Collision avoidance
  - Reach the target
  - Carry the camera(s)
  - Device dependency vs. Portability

VeRoNa



# **VeRoNa Simulator**

# VeRoNa Simulator

VeRoNa Simulator ● ●

VALEN ● ● ●

BRUMA ● ● ●



## VeRoNa



## Vehicle and Robot Navigation Simulator



# VeRoNa Simulator

VeRoNa Simulator ●●

VALEN ●●●

BRUMA ●●●

- Policy-based programming
- Unity Game Engine
  - Portability and low cost
  - Capable of loading maps, models and scripts
  - Graphics, AI and network inter-operant engines
- Top-down approach
  - Path planning
  - Trajectory control
  - Odometry



**VALEN**

*(Variable Amount of Local Estimation  
Nodes)*

# VALEN::Conjectures

VALEN ●●●

BRUMA ●●●

Near Future ●

- Conjecture 1
  - Noise and inaccuracies harm distinct image regions in distinct ways and amounts
- Conjecture 2
  - It is possible to enhance the generated hypotheses quality by generating hypotheses over specific image regions
- Conjecture 3
  - It is possible to speed up the hypotheses evaluation process quality by generating hypotheses over specific image regions



# VALEN::Conceptual Example

VALEN ●●●

BRUMA ●●●

Near Future ●



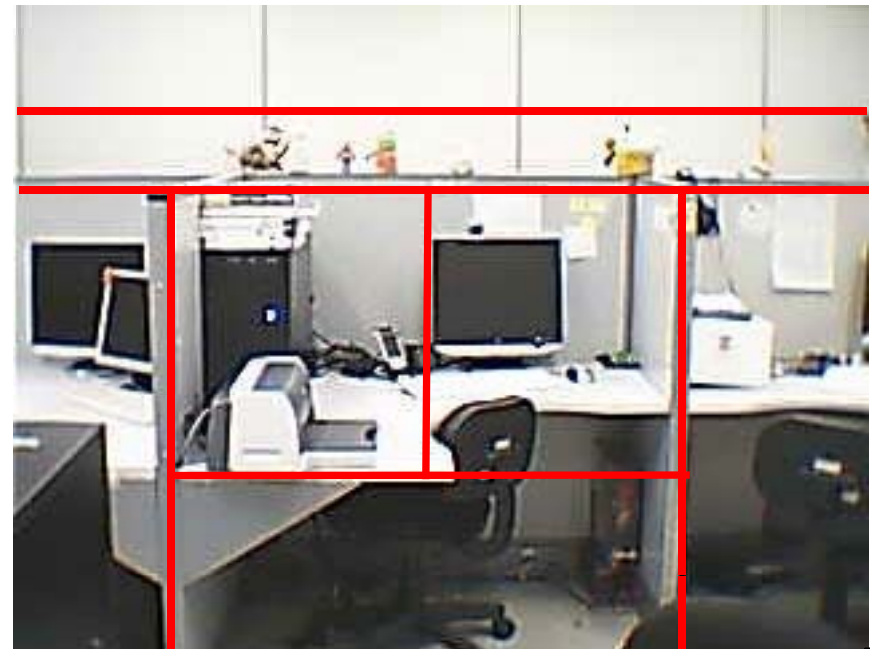


# VALEN::Finding Local Estimation Nodes

VALEN ●●●

BRUMA ●●●

Near Future ●



# **BRUMA**

*(Block Resizing for UnderManned  
Amount of Assays Avoidance)*

# BRUMA::Preemption Schemes

VALEN ●●●

BRUMA ●●●

Near Future ●

Scheme

Score

Depth-first

$$\forall h_i, \pi_m(h_i) = \sum_{j=1}^m \rho(o_j, h_i)$$

Breadth-first

$$\forall o_j, \pi_n(o_j) = \sum_{i=1}^n \rho(o_j, h_i)$$

Hybrid

$$\forall o_j, \pi_n(o_j) = \sum_{i=1}^n \rho(o_j, h_{i|j})$$



# BRUMA::Preemption Schemes

VALEN ●●●

BRUMA ●●●

Near Future ●

Depth-first

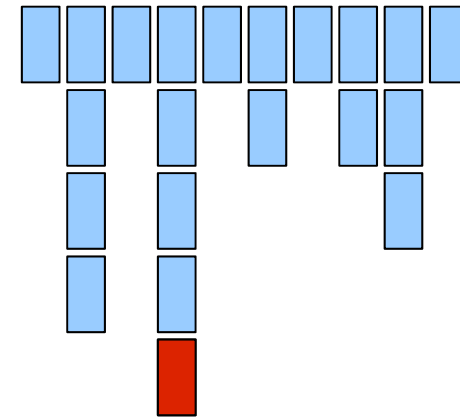
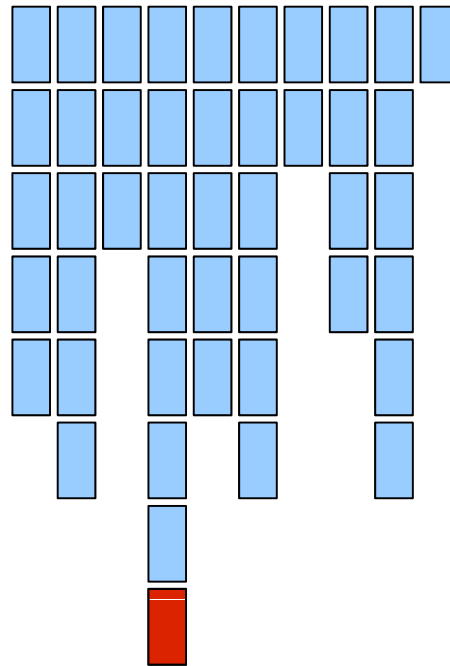
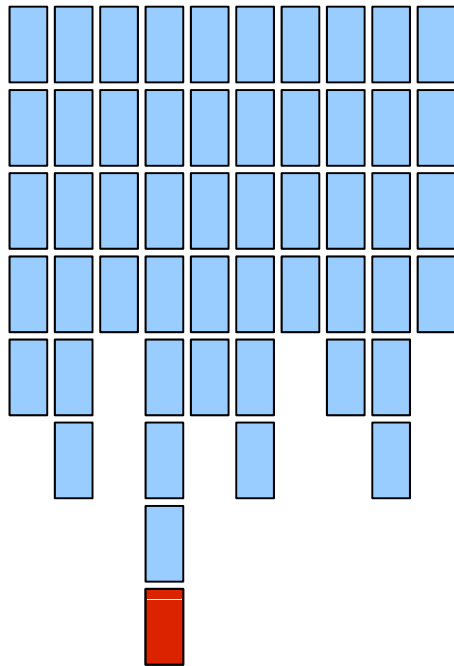
Breadth-first

Hybrid

$$\forall h_i, \pi_m(h_i) = \sum_{j=1}^m \rho(o_j, h_i)$$

$$\forall o_j, \pi_n(o_j) = \sum_{i=1}^n \rho(o_j, h_i)$$

$$\forall o_j, \pi_n(o_j) = \sum_{i=1}^n \rho(o_j, h_{i|j})$$



# BRUMA::Comparing the Preemption Functions

VALEN ●●●

BRUMA ●●●

Near Future ●

- Standard function

$$f(i) = \left\lceil M \cdot 2^{-\left\lfloor \frac{i}{B} \right\rfloor} \right\rceil$$

- BRUMA

$$f(i) = \left\lceil M_i \cdot p_i^{-\left\lfloor \frac{i}{B_i} \right\rfloor} \right\rceil$$

$M$  = number of available hypotheses  
 $i$  = the  $i$ -th iteration  
 $B$  = block size

$M_i$  = number of available hypotheses  
 $p_i$  = elimination factor  
 $B_i$  = block size at the  $i$ -th iteration



**Near Future**

# Near Future

VALEN ●●●

BRUMA ●●●

Near Future ●

- Six months in George Mason University (VOLLG Positioning)
- Keep developing VeRoNa Simulator
- Deliver a scheme for selecting the values of parameters in BRUMA function
- Develop the VALEN “layer” discovery algorithm

