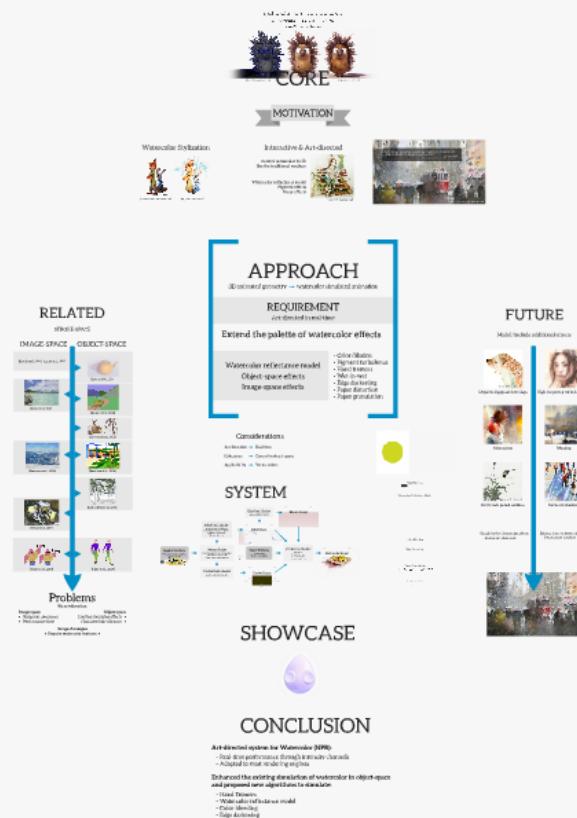


QA



thank you
Expressive 2016

Art-directed Watercolor Rendered Animation

S. E. Montesdeoca H. S. Seah H.-M. Rall

Nanyang Technological University



Art-directed Watercolor Rendered Animation

S. E. Montesdeoca H. S. Seah H.-M. Rall

Nanyang Technological University



[Henry © Oculus Story Studio]

CORE

[Montesdeoca et. al., 2016]

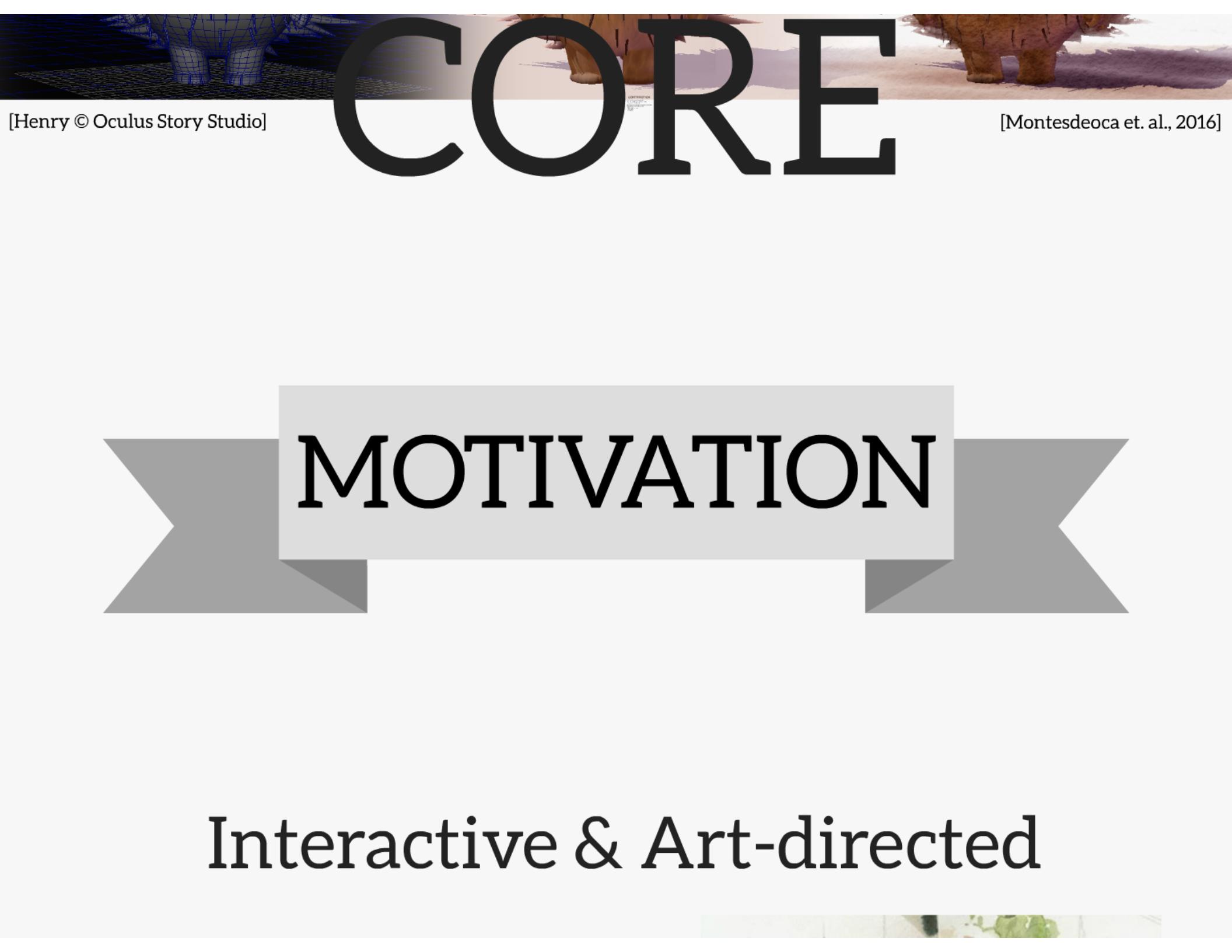
CONTRIBUTION

Art-directed system for Watercolor (NPR):

- Real-time performance through intensity channels
- Adapted to most rendering engines

Enhanced the existing simulation of watercolor in object-space and proposed new algorithms to simulate:

- Hand Tremors
- Watercolor reflectance model
- Color-bleeding
- Edge darkening



[Henry © Oculus Story Studio]

[Montesdeoca et. al., 2016]

CORE

MOTIVATION

Interactive & Art-directed

Watercolor Stylization



[© Walt Disney Animation, 2016]



[Lei, 2016, *hand-painted]

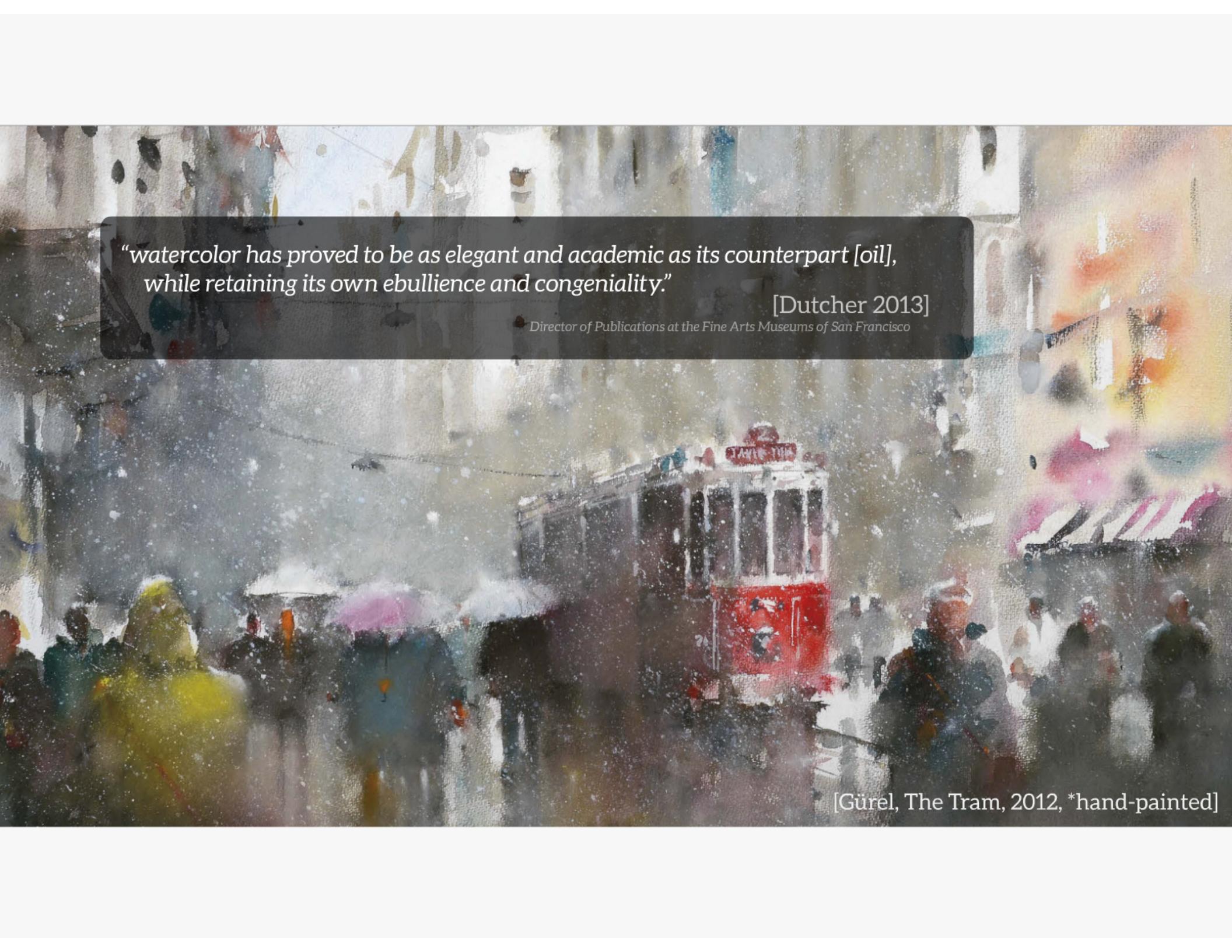
Interactive & Art-directed

Control watercolor in 3D
like the traditional medium

Watercolor reflectance model
Pigment effects
Paper effects



[Hung, 2015, *hand-painted]

A watercolor painting depicting a rainy urban street. In the center, a red double-decker tram is moving along a track. Several people are walking on the sidewalk, some holding pink and white umbrellas. The background shows buildings and trees, with a warm glow from streetlights or windows.

"watercolor has proved to be as elegant and academic as its counterpart [oil], while retaining its own ebullience and congeniality."

[Dutcher 2013]

Director of Publications at the Fine Arts Museums of San Francisco

[Gürel, The Tram, 2012, *hand-painted]

Art-directed Watercolor Rendered Animation

S. E. Montesdeoca H. S. Seah H.-M. Rall

Nanyang Technological University



[Henry © Oculus Story Studio]

[Montesdeoca et. al, 2016]

CORE

MOTIVATION

Watercolor Stylization



[© Walt Disney Animation, 2016]



[Lei, 2016, "hand-painted"]

Interactive & Art-directed

Control watercolor in 3D
like the traditional medium

Watercolor reflectance model
Pigment effects
Paper effects



[Hung, 2015, "hand-painted"]



RELATED

STROKE-SPACE

IMAGE-SPACE

OBJECT-SPACE

[David Small, 1991] [Curtis et al., 1997]



IMAGE-SPACE

[David Small, 1991] [Curtis et al., 1997]

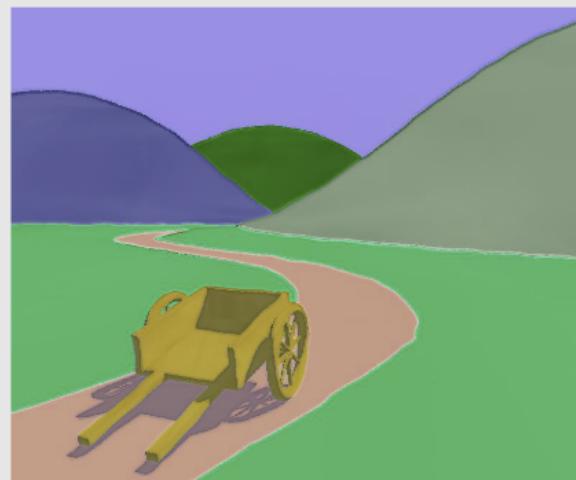


[Johan et al., 2004]

OBJECT-SPACE



[Lum and Ma, 2001]

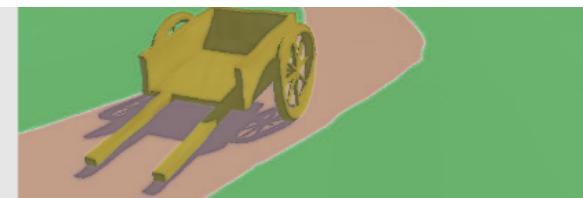


[Burgess et al., 2005]





[Johan et al., 2004]



[Burgess et al., 2005]



[Lei and Chang, 2006]



[Bousseau et al., 2006]



[Bousseau et al., 2006]





[Bousseau et al., 2006]



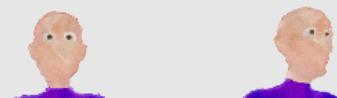
[Bousseau et al., 2006]



[Wang et al., 2014]

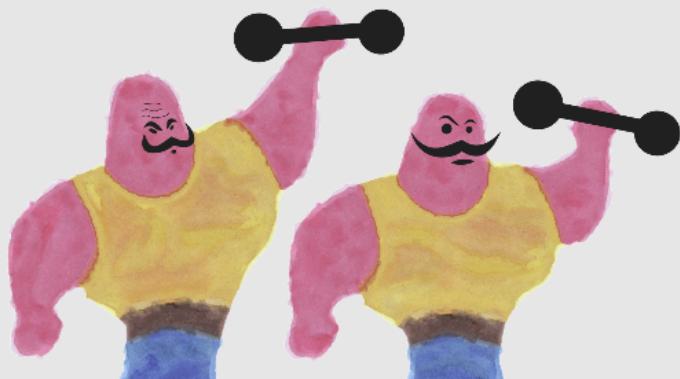


[Luft and Deussen, 2006]





[Wang et al., 2014]



[Fišer et al., 2014]

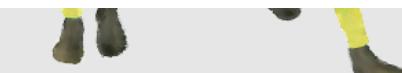


[Fišer et al., 2014]

Problems



[Fišer et al., 2014]



[Fišer et al., 2014]



Problems

No art-direction

Image-space

- Temporal coherence
- Performance time

Object-space

- Limited simulated effects
- Characteristic vibrancy

Image Analogies

- Require watercolor textures

Watercolor Stylization



Disney's Wreck-It Ralph, 2012

Interactive & Art-directed

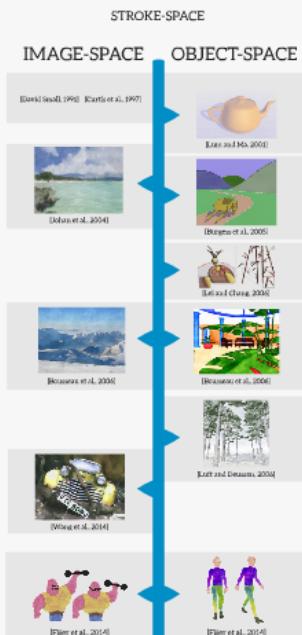


Wang, 2013. *Painted Self*



Wang, 2013. *Painted Street*

RELATED



Problems

No art-direction

- | | |
|-------------------------------|-----------------------------|
| Image-space | Object-space |
| • Temporal coherence | • Limited simulated effects |
| • Performance time | • Characteristic vibrancy |
| • Image Analogies | • |
| • Require watercolor textures | • |

APPROACH

3D animated geometry → watercolor simulated animation

REQUIREMENT

Art-directed in real-time

Extend the palette of watercolor effects

Watercolor reflectance model

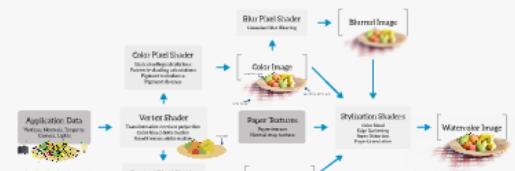
- Object-space effects
- Image-space effects

- Color dilution
- Pigment turbulence
- Hand tremors
- Wet-in-wet
- Edge darkening
- Paper distortion
- Paper granulation

Considerations

- Art-direction → Real-time
- Coherence → Control in object-space
- Applicability → Vertex colors

SYSTEM



FUTURE

Model/include additional effects



Enhance frame-to-frame coherence

- Increase contrast/opacity
- Dynamic paper simulation



SHOWCASE



CONCLUSION

Art-directed system for Watercolor (NPR):

APPROACH

3D animated geometry → watercolor simulated animation

REQUIREMENT

Art-directed in real-time

Extend the palette of watercolor effects

- Color dilution
- Pigment turbulence

REQUIREMENT

Art-directed in real-time

Extend the palette of watercolor effects

Watercolor reflectance model

Object-space effects

Image-space effects

- Color dilution
- Pigment turbulence
- Hand tremors
- Wet-in-wet
- Edge darkening
- Paper distortion
- Paper granulation

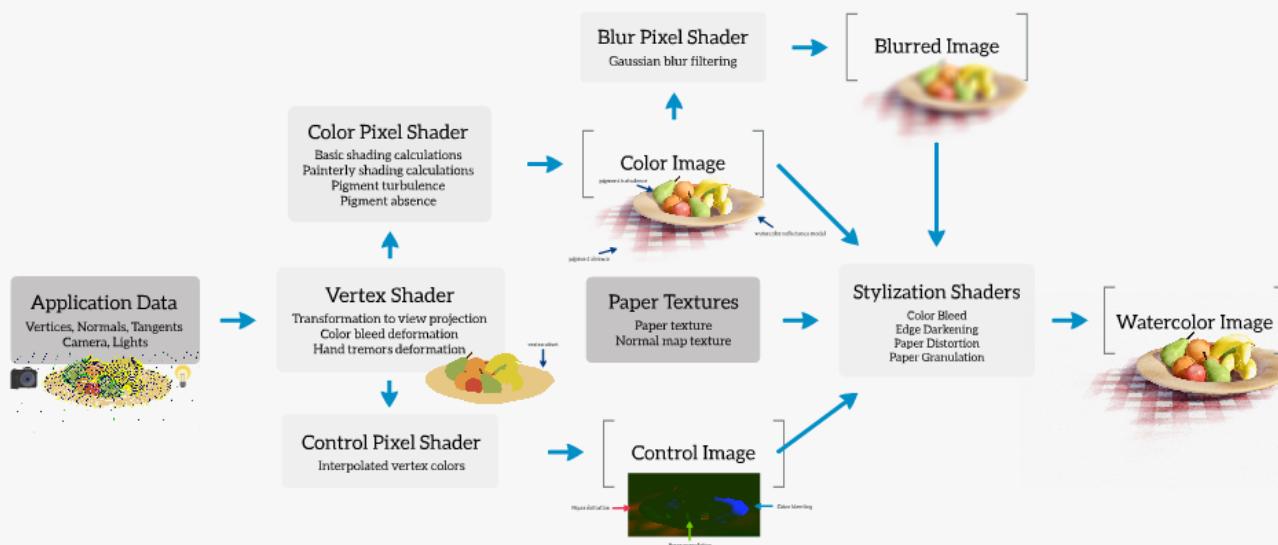
• Paper granulation

Considerations

- Art-direction → Real-time
- Coherence → Control in object-space
- Applicability → Vertex colors



SYSTEM



$$V_d = \text{sgn}(t) \times s - V \times f_1 \times t \times f_2$$

$$V_f = V + V_{d,1} + \text{sgn}(F \cdot \vec{N})$$

Watercolor Reflectance Model

$$D_A = \frac{\vec{L} \cdot \vec{N} + (d_A - 1)}{d_A}$$

$$C_1 = C + (D_A \times \epsilon)$$

$$C_2 = d \times D_A (C_p - C_s) + C_s$$

$$G_1 = \begin{cases} C^{(1-Ctr \times 0)} & \text{if } Ctr < 0.5 \\ (Ctr - 0.5) \times 2(C_p - C) + C & \text{if } Ctr \geq 0.5 \end{cases}$$



Color Bleeding

$$I_{cr} = Ctr(I_c I_r + I_c)$$

Edge Darkening

$$I_{cd} = I_d^{(Ctr \times 0.5 - 0.5)}$$

Paper Granulation

$$I_g = I(I - P_w) + (1 - I)^{1 - (Ctr \times dP_w)}$$

Detailed implementation → Paper



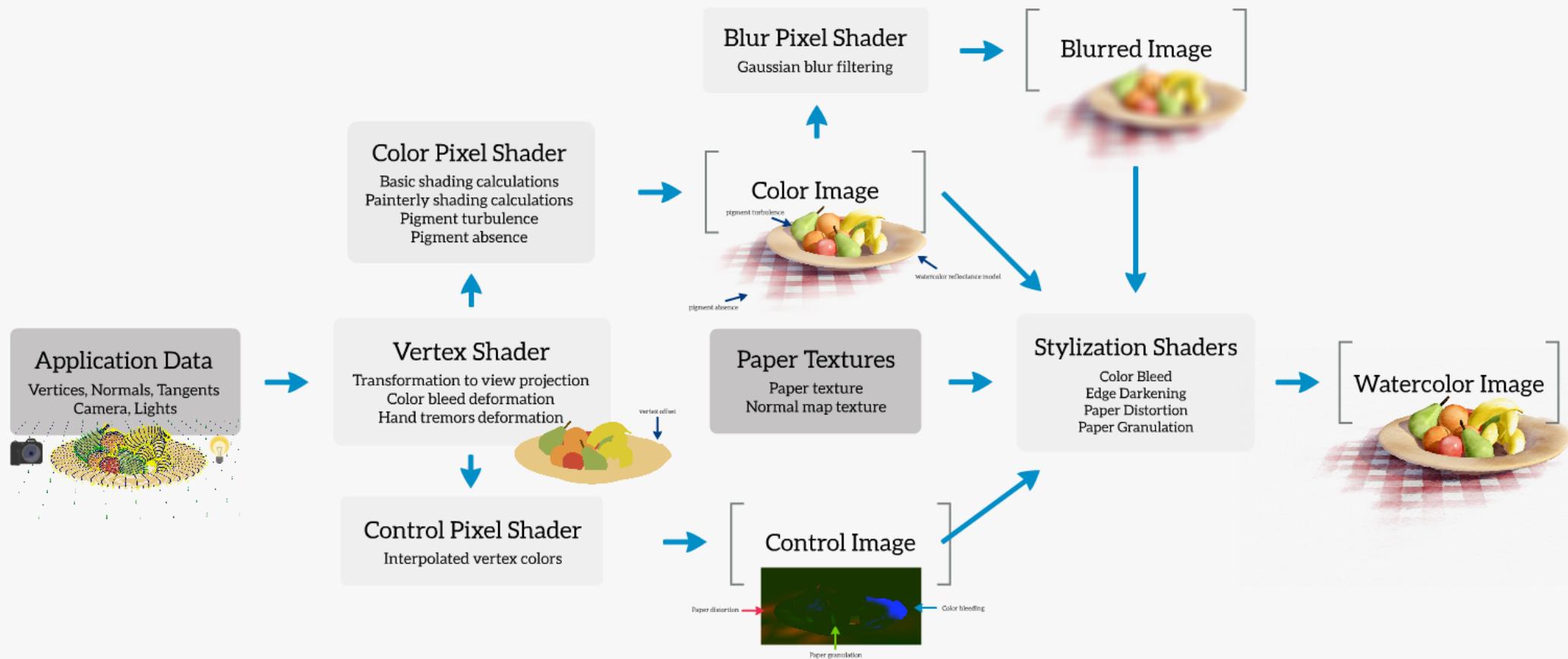
Considerations

Art-direction → Real-time

Coherence → Control in object-space

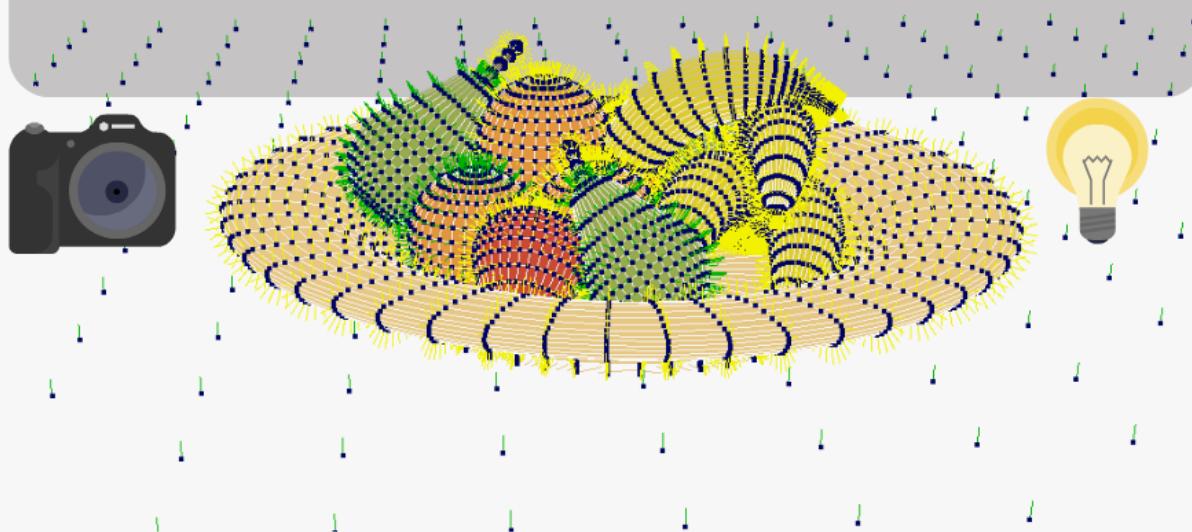
Applicability → Vertex colors

SYSTEM



Application Data

Vertices, Normals, Tangents
Camera, Lights



Pigment absence



Vertex Shader

Transformation to view projection

Color bleed deformation

Hand tremors deformation

vertex offset
A large blue arrow pointing downwards, indicating the flow of data or control from the Vertex Shader section to the Control Pixel Shader section.



Control Pixel Shader



Control Pixel Shader

Interpolated vertex colors



Control Image

Paper distortion



Color bleeding



Paper granulation



Pigment absence



Vertex Shader

Transformation to view projection

Color bleed deformation

Hand tremors deformation

vertex offset
A large blue arrow pointing downwards, indicating the flow of data or control from the Vertex Shader section to the Control Pixel Shader section.



Control Pixel Shader

Color Pixel Shader

Basic shading calculations

Painterly shading calculations

Pigment turbulence

Pigment absence



Vortex Shader



Gaussian blur filtering



Blur Pixel Shader

Gaussian blur filtering



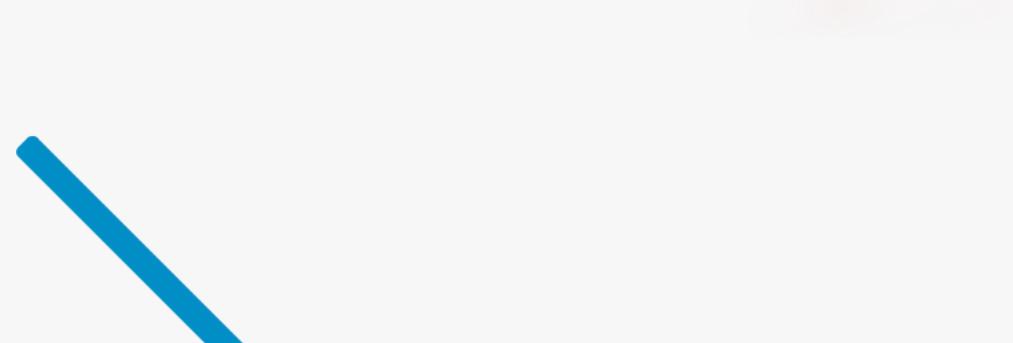
Color Image

pigment turbulence

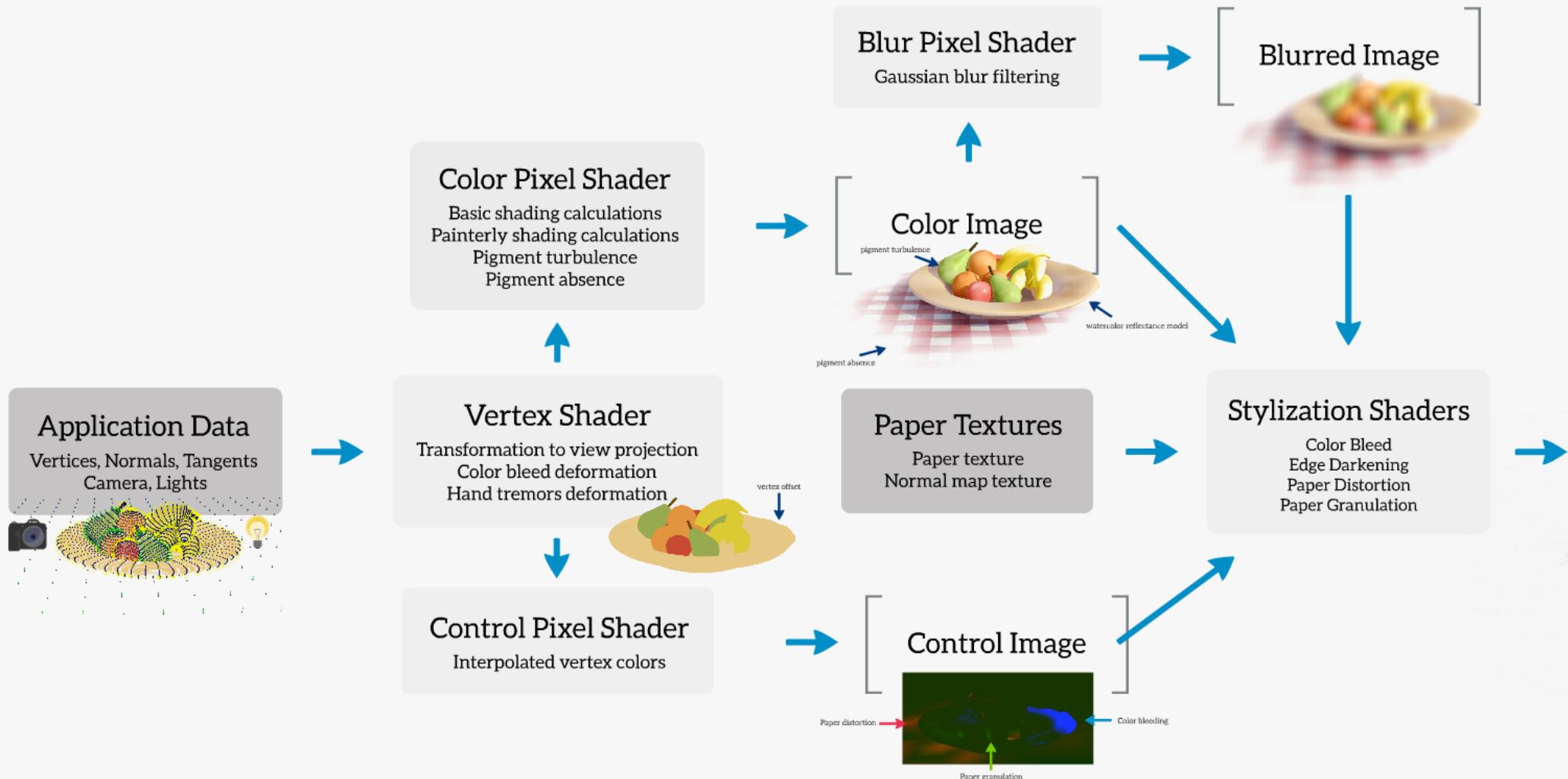




[Blurred Image]



SYSTEM



color reflectance model

Stylization Shaders

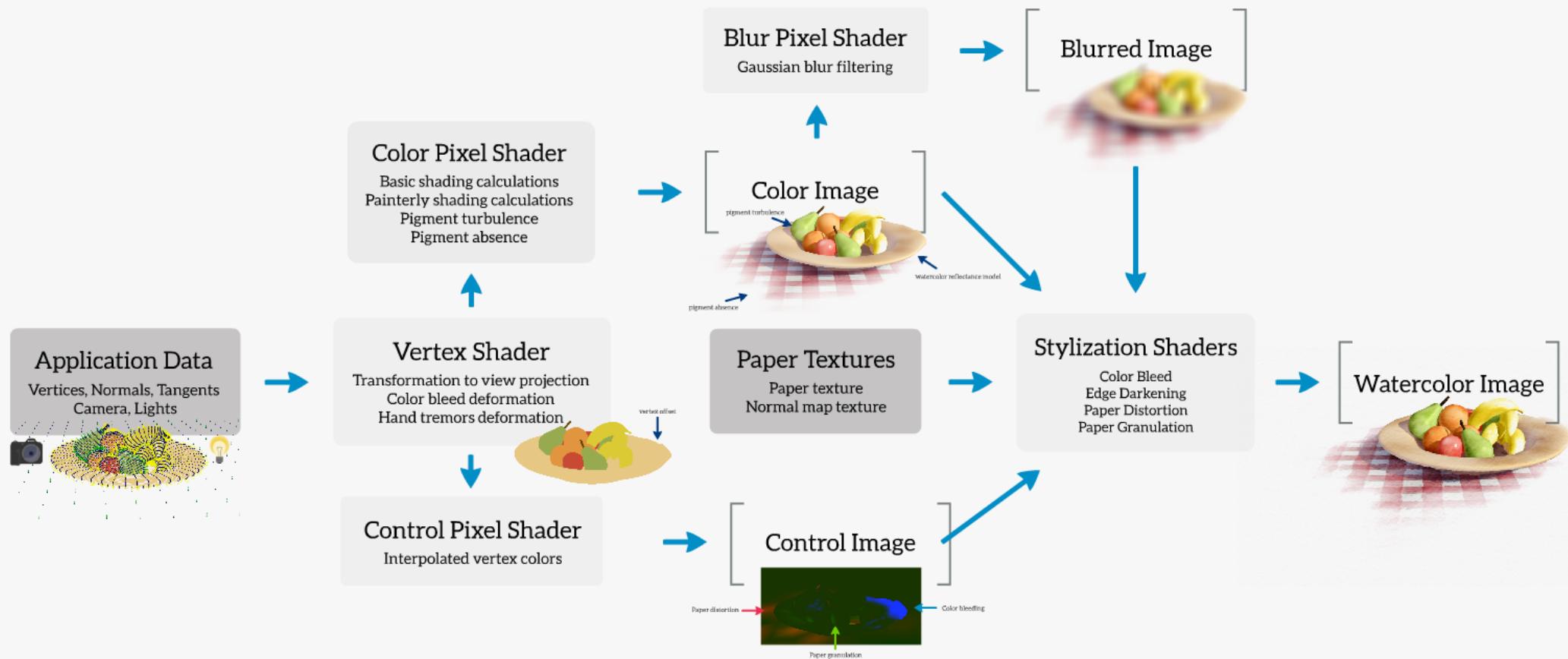
- Color Bleed
- Edge Darkening
- Paper Distortion
- Paper Granulation

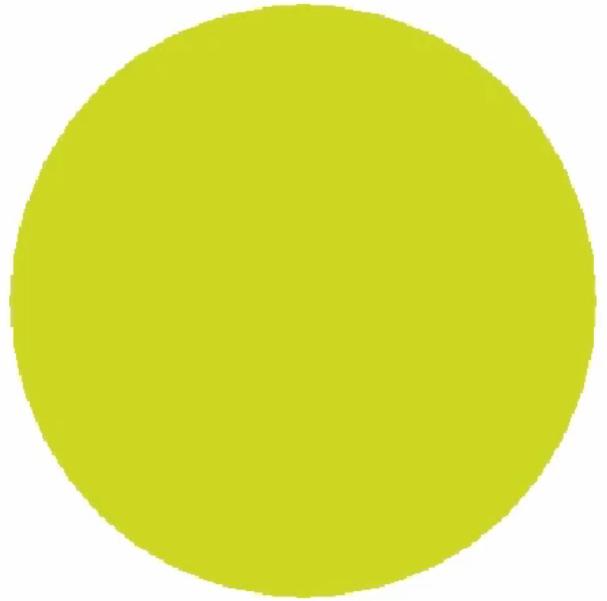


Watercolor Image



SYSTEM





Hand Tremors

$$V_o = \sin(T \times s + V \times f) \times t \times P_p$$

$$V_t = V + V_o(1 - a(\vec{V} \cdot \vec{N}))$$

V_o	-	Vertex offset
T	-	Time
s	-	Speed
V	-	Vertex position
f	-	Frequency
t	-	Tremor amount
P_p	-	Projection speed
V_t	-	Vector tremor
\vec{V}	-	View direction
\vec{N}	-	Vertex normal

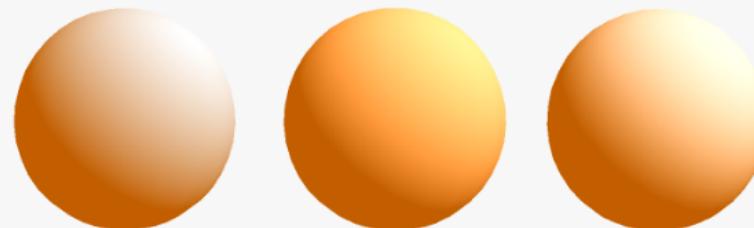
Watercolor Reflectance Model

$$D_A = \frac{\vec{L} \cdot \vec{N} + (d_A - 1)}{d_A}$$

$$C_c = C + (D_A \times c)$$

$$C_d = d \times D_A(C_p - C_c) + C_c$$

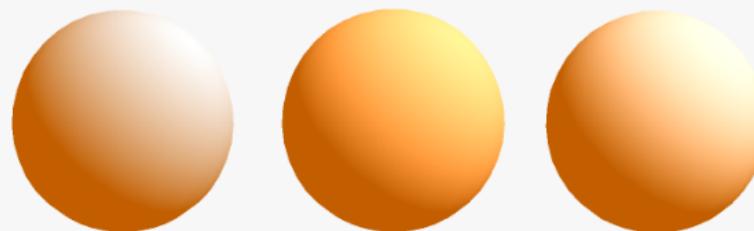
D_A	-	Area of effect
\vec{L}	-	Light direction
d_A	-	Dilute area
C_c	-	Cangiante color
c	-	Cangiante
C_d	-	Diluted color
d	-	Dilution
C_p	-	Paper color
C_t	-	Turbulence color
$Ctrl$	-	Control channel



$$D_A = \frac{\vec{L} \cdot \vec{N} + (d_A - 1)}{d_A}$$

$$C_c = C + (D_A \times c)$$

$$C_d = d \times D_A(C_p - C_c) + C_c$$



$$C_t = \begin{cases} C^{3-(Ctrl \times 4)} & \text{if } Ctrl < 0.5 \\ (Ctrl - 0.5) \times 2(C_p - C) + C & \text{if } Ctrl \geq 0.5 \end{cases}$$



Color Bleeding

$$I_{cb} = Ctrl(I_b - I) + I$$

D_A - Area of effect
 \vec{L} - Light direction
 d_A - Dilute area
 C_c - Cangiante color
 c - Cangiante
 C_d - Diluted color
 d - Dilution
 C_p - Paper color
 C_t - Turbulence color
 $Ctrl$ - Control channel



Color Bleeding

$$I_{cb} = Ctrl(I_b - I) + I$$

Edge Darkening

$$I_{ed} = I_{cb}^{1+Ctrl \times max(I_b - I)}$$



I_{cb} - Color bleeding image
 I_b - Blurred image
 I - Color image
 I_{ed} - Edge darkening image
 d - Density
 P_{iv} - Inverted paper texture
 I_g - Granulated image
 $Ctrl$ - Control channel

Paper Granulation

$$I_g = I(I - P_{iv}) + (1 - I)I^{1+(Ctrl \times dP_{iv})}$$

Detailed implementation → Paper



SHOWCASE



CONCLUSION

Art-directed system for Watercolor (NPR):

- Real-time performance through intensity channels
- Adapted to most rendering engines

**Enhanced the existing simulation of watercolor in object-space
and proposed new algorithms to simulate:**

- Hand Tremors
- Watercolor reflectance model
- Color-bleeding
- Edge darkening

FUTURE

Model/include additional effects



Model/include additional effects



[Dimdi, 2014, *hand-painted]

Unpainted gaps and overlaps



[Mack, 2012, *hand-painted]

High frequency turbulent noise



[Dimdi, 2014, *hand-painted]

Unpainted gaps and overlaps



[Mack, 2012, *hand-painted]

High frequency turbulent noise



Abstraction



Massing





[Gürel, 2014, *hand-painted]

Abstraction



[Quin, n.a. *hand-painted]

Dry brush, pencil outlines



[Schaller, n.a., *hand-painted]

Massing



[Soan, n.a., *hand-painted]

Painterly shadows

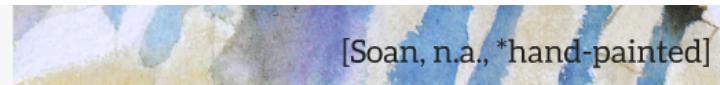


[Quin, n.a. *hand-painted]

Dry brush, pencil outlines

Encode further characteristic effects

- Increase control spectrum



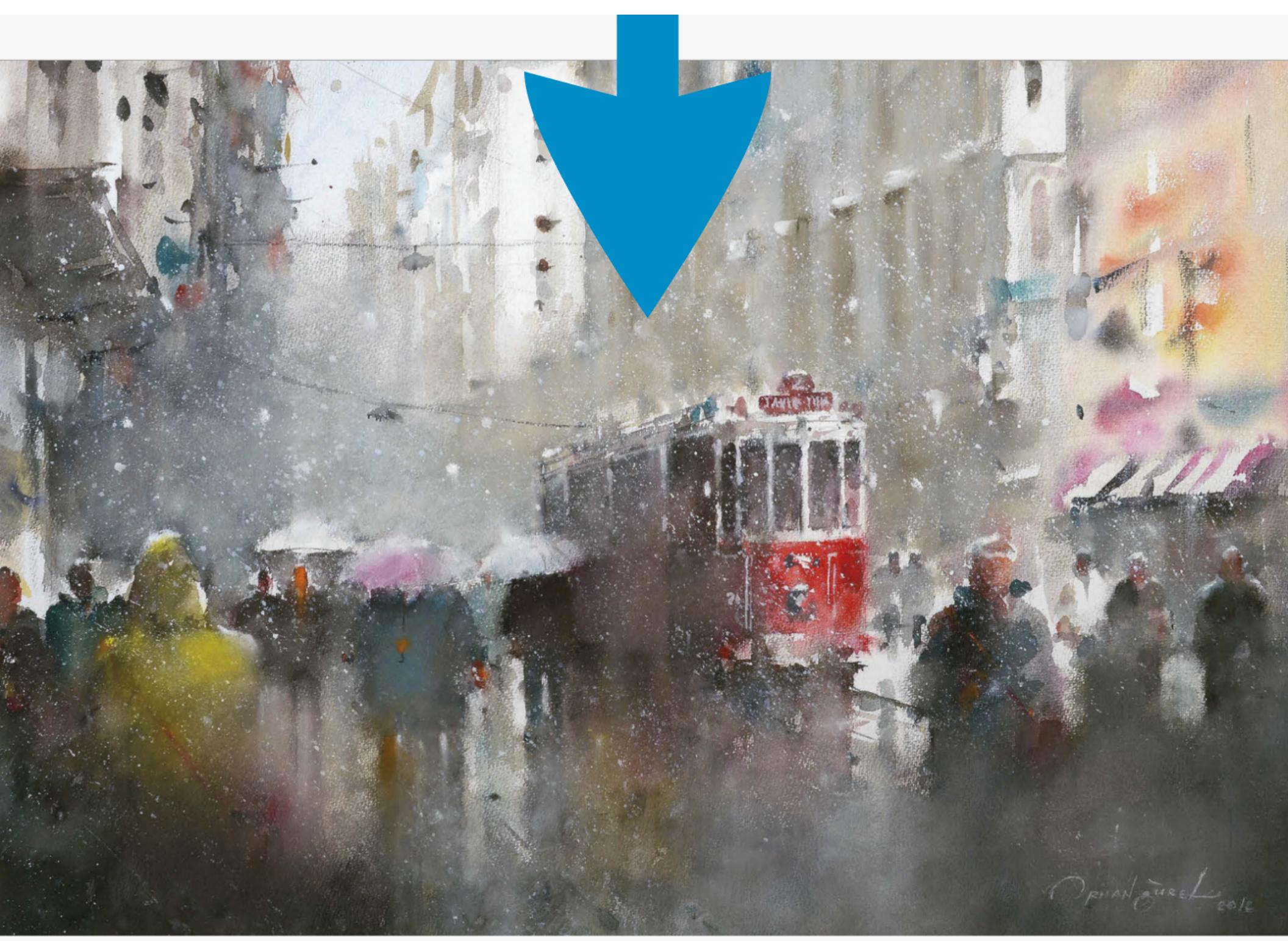
[Soan, n.a., *hand-painted]

Painterly shadows

Enhance frame-to-frame coherence

- Dynamic paper simulation





Dimitrijević 2012

- Real-time performance through intensity channels
- Adapted to most rendering engines

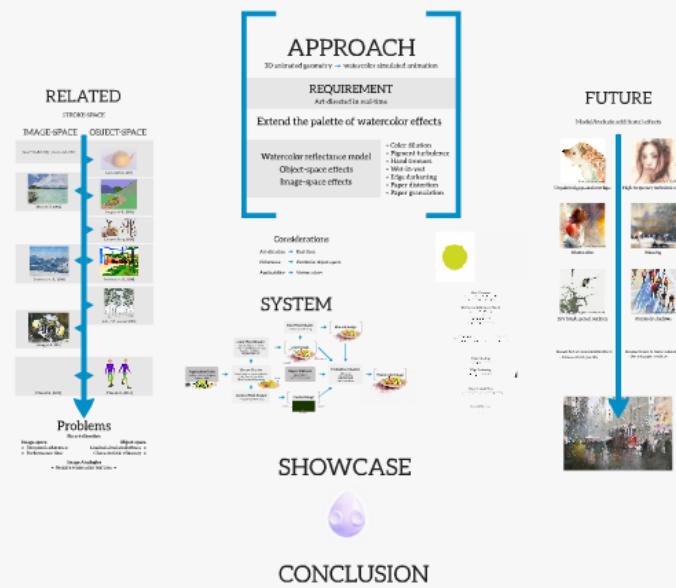
Enhanced the existing simulation of watercolor in object-space
and proposed new algorithms to simulate:

- Hand Tremors
- Watercolor reflectance model
- Color-bleeding
- Edge darkening

thank you

Expressive 2016

QA



CONCLUSION

Art-directed system for Watercolor [INPRO]

- Real-time performance on through intensity channels.
- Adjusted to most rendering engines.

Enhanced the esthetic simulation of watercolor

and proposed new algorithms to simulate:

- Hand Thinner
- Watercolor reflectance model

- Color bleeding
- Edge darkening

100

—
—

— 1 —

— 1 —