Spatiotemporal Video Amplification

6.111 Final Project Presentation
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See the Invisible

Color Amplification
Motivation

- Improvements in camera technology have enabled capturing of small changes
- These changes are often invisible to the naked eye
- Real time video processing is computation intensive
Applications

• Biomedical Imaging
• Medical Monitoring Systems
• Physics and Chemistry Research
• Surveillance
• Sports
Theory: Temporal Amplification

- Input at $T = t$
- Input at $T = t + 1$
- Output at $T = t + 1$

Intensity ($I$) vs Position ($x$)
Theory: Temporal Amplification

- Input at $T = t$
- Input at $T = t + 1$
- Output at $T = t + 1$

The diagram shows a graph with axes labeled 'Intensity ($I$)' and 'Position ($x$)'. The partial derivative of intensity with respect to time ($\frac{\partial I}{\partial t}$) and a lambda ($\lambda$) times the partial derivative of intensity with respect to time ($\lambda \frac{\partial I}{\partial t}$) are also indicated.
Theory: Spatial Amplification

- Input at $T = t$
- Input at $T = t + 1$
- Output at $T = t + 1$

Intensity ($I$) vs. Position ($x$)
Theory: Spatial Amplification
Theory: Spatial Amplification

- Input at $T = t$
- Input at $T = t + 1$

$$\frac{dx}{dt} = \frac{\partial I}{\partial t} = \frac{\partial I}{\partial x}$$
Theory: equations

\[ J(x, y, t) = \]

\[ I \left( x + \lambda \frac{\partial I}{\partial t}, y + \lambda \frac{\partial I}{\partial y}, t \right) + \mu \frac{\partial I}{\partial t} \]  \hspace{1cm} (1)

\[ J(x, y) = I(x + \lambda \frac{I(x, y, t) - I(x, y, t - k)}{I(x, y, t) - I(x - k, y, t)}, t) \]

\[ y + \lambda \frac{I(x, y, t) - I(x, y, t - k)}{I(x, y, t) - I(x, y - k, t), t) \]

\[ + \mu \frac{I(x, y, t) - I(x, y, t - k)}{k} \]  \hspace{1cm} (2)
Hardware Implementation
Software Prototyping
Temporal Amplification
Software Prototyping
Spatial Amplification
Software Prototyping
Handling Noise
Timeline

– Week of Nov 12th –
  • ZBT RAM and preprocessing modules will be implemented.

– Nov 19th –
  • Demonstrate temporal amplification on grayscale images

– Nov 29th –
  • Demonstrate spatial amplification on grayscale images.

The remaining time will be used for testing and debugging. If time permits we will modify our design for full color operation and/or frequency selective capabilities.