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An Automatic and Locally Tunable Transformation Function for Fog and Haze Removal in Aerial Imagery

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An Automatic and Locally Tunable Transformation Function for Fog and Haze Removal in Aerial Imagery

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Dr.Vijayan K.Asari

Objective

- To develop an algorithm which is capable of visibility and color restoration of objects in the weather affected regions (haze, fog, smoke, rain etc.,) of an image.
- This would help in automatic recognition of objects in bad weather conditions.

Technical Approach – Hazy/foggy image enhancement

Physics/optics based haze/fog formation model is

\[ I(x) = J(x)I(x) + A(1 - e^(-d)) \]

where \( I(x) = \exp(-kd) \)

d is the depth information of a scene.

A is atmospheric light and is estimated from the luminance image J is the haze free image.

Specially designed nonlinear function

Luminance image is obtained using multi scale Gaussian of intensity image.

\[ I_{2}(x, y) = \frac{I_{1}(x, y)^{20} + I_{2}(x, y)^{20} + 2I_{1}(x, y)I_{2}(x, y) + 2I_{1}(x, y) + 2I_{2}(x, y)^{20}}{2} \]

Adaptive estimation of \( z \) from luminance

- \( z \) value can be calculated as
  \[
  z = \begin{cases} 
  0, & 0 \leq z < 50, \\
  -50, & 50 \leq z < 150, \\
  100, & 150 \leq z 
  \end{cases}
  \]

Transmission estimation \( t(x) = 1 - I_{2}(x) \)

- The transmission image is processed using local median filtering to minimize the artifacts around depth edges
- The final color image is obtained by substituting the estimated transmission in the model equation.

Sample Results

Sample Images with Uniform Depth

Sample Images with Non-uniform Depth

Computational time

<table>
<thead>
<tr>
<th>Hazy Image Enhancement</th>
<th>MATLAB</th>
<th>C++</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image size (pixels)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400x2672</td>
<td>560 sec</td>
<td>0.429 sec</td>
</tr>
</tbody>
</table>

Sample results on bad weather conditions

Sample results on hazy aerial database

Sample results on under water images

Sample results on Mars images

Ongoing Research

- Use of multiple sensor information.
- Fusion of MWIR and RGB image information.
- Extend this technique to different weather conditions like rain, snow etc.,
- Integrate this system with complex lighting environments.