The effect of image enhancement algorithms on convolutional neural networks

José A. Rodríguez-Rodríguez\textsuperscript{1}, Miguel A. Molina-Cabello\textsuperscript{1,2}, Rafaela Benítez-Rochel\textsuperscript{1,2}, Ezequiel López-Rubio\textsuperscript{1,2}

\textsuperscript{1}Department of Computer Science, University of Malaga, Malaga, Spain
\textsuperscript{2}Biomedic Research Institute of Malaga (IBIMA)

joseantoniorodriguez@uma.es, \{miguelangel,benitez,ezeqlr\}@lcc.uma.es

Methodology

- Image brightness has an impact on the CNN performance
- Image rescale can be carried out introducing Bright Scale (b) as:
  \[
  \hat{\phi} = \text{floor}\left(\frac{\phi + \frac{1}{2}}{b}\right) = \text{floor}\left(\frac{1}{b}\phi + \frac{1}{2}\right)
  \]
- A Quantization Error is produced:
  \[
  E = |b \cdot \hat{\phi} - \phi| = |b \cdot \text{floor}\left(\frac{1}{b}\phi + \frac{1}{2}\right) - \phi|
  \]

Experimental Results

- CNN performance is degraded as higher the bright scale (darker images)
- Four contrast enhancement algorithms have been used in the experiments: Gamma Correction (GC), Logarithm Transformation (LT), Histogram Equalization (HE) and Contrast-Limited Adaptive Histogram Equalization (CLAHE)
- Each Accuracy-1 point is calculated through 1000 images chosen randomly in the ILSVRC2012 Dataset

Conclusions

- It has been demonstrated the four contrast enhancement algorithms employed improve Accuracy-1 for AlexNet, GoogleNet and ResNet-34 for dark images
- Logarithm Transformation is the best algorithm for dark images but it presents some issues for brighter ones. The improvement is around 40% for a bright scale (b) of 10
- The other algorithms are more robust to be used in a wider range of brightness (GC, HE and CLAHE)