Small Object Detection by Generative and Discriminative Learning

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Problem

Small object detection is a challenging problem due to the limited information. Existing methods focus on improving classification accuracy but still suffer from the limitation of bounding box prediction.

Solution

We propose a detection framework by generative and discriminative learning. A reconstruction generator network is designed to reconstruct the mapping from low frequency to high frequency for anchor box prediction. A detector module extracts the regions of interest (ROIs) from generated results and implements a RoI-Head to predict object category and refine bounding box.

Framework

We argue a preferable way to implement a reconstruction network on the detection module, which is different from the previous work that applies reconstruction to the discriminator module. The purpose of such a framework design is to deblur objects and produce more details for bounding box prediction so that the detection module can identify the anchor box of small object more precisely.

Result

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\[ L_{adv} = \frac{1}{m} \sum_{i=1}^{m} \log(1 - D_{\theta_D}(G_{\theta_G}(x_{LR}^{(i)}))) \]

\[ L_{MSE} = \frac{1}{m} \sum_{i=1}^{m} \left\| z_{HR}^{(i)} - G_{\theta_G}(x_{LR}^{(i)}) \right\|_2^2 \]

\[ L_{TV} = \frac{1}{r^2 WH} \sum_{i=1}^{W} \sum_{j=1}^{H} \left\| G_{\theta_D}(z_{LR}^{(i)}) \right\|_1 + \sum_{i=1}^{m} \log(D_{\theta_D}(z_{HR}^{(i)})) + \log(D_{\theta_D}(z_{LR}^{(i)})) \]

\[ L_{cls} = \frac{1}{m} \sum_{i=1}^{m} \sum_{l=1}^{n} \log p^{(i)} p^{(i)} + (1 - p^{(i)})(1 - p^{(i)})) - \log(D_{\theta_D}(z_{HR}^{(i)})) \]

\[ L_{reg} = \frac{1}{m} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{x,y,w,h} \left| y_{i} - 1 \right| \left( S_{l'} (t_{SR} - t_{LR}^{(i)}) \right) \]

\[ \max_{\theta_D} \min_{\theta_G} \left( \frac{1}{m} \sum_{i=1}^{m} \log D_{\theta_D}(x_{HR}^{(i)}) + \alpha L_{adv} + \beta L_{cls} + \gamma L_{reg} + \gamma L_{TV} + L_{MSE} \right) \]

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