Assignment 2 : CS-512 Computer Vision

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Review questions

Question 1: Noise and Filtering

(a) $SNR = \frac{E_s}{E_n} = \frac{\sigma_s^2}{\sigma_n^2}$; $SNR[dB] = 10\log\frac{E_s}{E_n}$

(b) - Gaussian noise: is statistical noise having a probability density function equal to that of a normal distribution.
- Impulsive noise: consist on pulses of ON/OFF of "short" duration.
- The median filter handles impulsive noise better.

(c) $$\begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix} * \begin{bmatrix}2&2&2\\2&2&2\\2&2&2\end{bmatrix} = \begin{bmatrix}8&12&8\\12&18&12\\8&12&8\end{bmatrix}$$

(d) Convolving along rows and colums separetely will be more efficient, first one and the other instead of both at the same time. 2D convolt: $M \times N \times m^2$ opp.

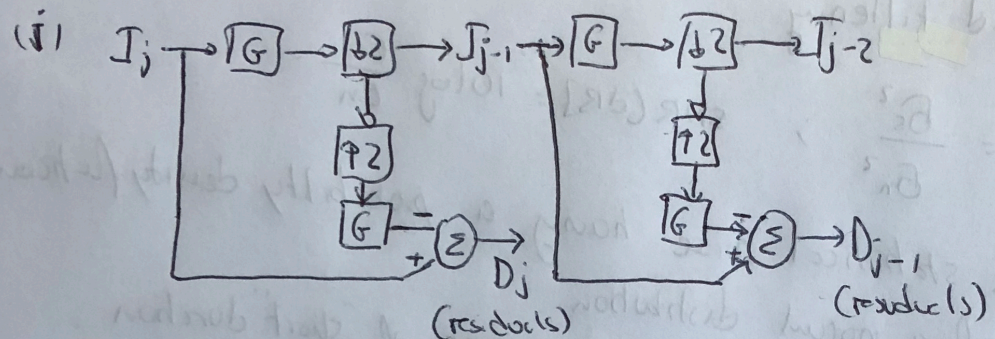
(e) 1. Zero padding: put zeros for non in matrix values
2. Replication: copy the value next to where there is no value
3. Ignore the boundaries: when filter is small and the image is large

(f) $\frac{1}{9}\begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix}$ The sum is 9. The 1/9 is to not overpass the 255 value and to get the medium value of the surrounded pixels

(g) Doing the convolution along rows and then along columns or vice versa. this option is more efficient $2m \times M \times N$ than $M \times N \times m^2$

(h) $\sigma \leq \frac{m}{5}$, if m is the size and $\sigma = 2$, $m \geq 10$.

(i) Each level divides by two the dimensions. It is used for Compression. The aditional processing is $\frac{1}{3}$ compared to an image.

(j) 

A Gaussian filter is applied then it is reduced by two and augmented again and a Gaussian filter is applied again. Finally the errors (residuals) and the processed image are computed. It is used for compression

Question 2: Edge detection

(a) It is an important feature to detect in images to highlight important parts of the image. Feature invariant, consistent detection, correspond to scene elements

(b) 1) Smoothing (to reduce noise)
2) Enhance edges
3) Detect edges
4) localize edges

(c) Canny and Sobel filter. It is important for chances in the image and it is used for edge detection

(d) Sobel filter consist on the convolution of a smoothing filter and a derivative filter

) Using our function sampled. It is reconstructed, derivated and sampled it again

$$f[x] \Rightarrow f(x) * h(x) \longrightarrow f[x] * h'(x)$$

$h(x)$ is approximated with $G(x) \rightarrow f(x) * G'(x)$

$$\begin{cases} I_x = I * G'[x] * G[y] \\ I_y = I * G'[y] * G[x] \end{cases} ; \quad G(x) = e^{\frac{-x^2}{2\sigma^2}} ; \quad G'(x) = \frac{-x}{\sigma^2} e^{\frac{-x^2}{2\sigma^2}} , \text{ with } \sigma = 2$$

(f) The first derivative is not precise for locating an edge, since a threshold is neede to determinate were the edge is. The second derivative allows to determinate the edge were it is zero crossing.

(g) With $r = \sqrt{x^2+y^2}$; $G = e^{\frac{-r}{2\sigma^2}}$; $\Delta^2 G = \frac{r^2 - 2\sigma^2}{r^4} e^{\frac{-r^2}{2\sigma^2}}$

Threshold $\rightarrow \begin{cases} 1 & \text{if } I * LoG > 0 \\ 0 & \text{if } I * LoG \leq 0 \end{cases}$, Edges at transisions $1 \to 0$ or $0 \to 1$

with $LoG = \nabla^2 G$

(h) Canny tries to detect edges along the direction of the maximum gradient, while the standard method uses vertical and horizontal directions.

The Condition is : $|\nabla(I * G)| > \tau$

(i) • Non maximum suppresion : a point is compared to its surrounding points in the direction of study. If it is larger than the others, the others could be discarded.

• Hysteresis thresholding : τ_H it is used to start tracking and τ_L to continue (with $\tau_H > \tau_L$)