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Computer vision - It is about making a computer understand images & videos & frames.

Industry 4.0

Images - Images are accuired imple impression a two dimentional discrete signal.

Net traisic - Transmission of data.

Why -jpeg format is popular = It gives a flexibility to compress in diff. degree.

Lossless compression technique → Png

Challenges in Computer vision

i) many nuisance parameters. Eg- illumination, object pose, view point, clutter.

ii) Intraclass variation. Eg - chair (there can be variety of chairs).

iii) Importance of content.

- marvin minsky → American Computer Scientist
- MIT → The massachusetts institute of technology

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Image formation

Initial part of vision

- Digital image - A 2D func. $f(x,y)$, where x & y are spatial coordinates. (intensity at x,y)
(We are going to have a discrete func by 2D matrix).

Electro magnetic spectrum

- Energy $\propto$ frequency
- Wavelength $\propto \frac{1}{\text{freq}}$

- only a small part of the wavelength spectrum only a little part is visible spectrum. only the lights reflected from the obj's within it are visible to us.

3) • 1 angstrong $= 10^{-10}$ m

Light → Based on light we have 2 types of images.

- monochromatic (single) (colour) → gray scale images
- Chromatic light bands

Chromatic light bands, Image acquisition using a single sensors, sensor strips, image acquisition process (2D array of sensors), a simple image formation model

Some typical ranges of illumination, Image sampling & quantization (process of converting analog ~~signal~~ img to digital ~~signal~~ img)

- Brightness - subjective measure

Image acquisition

3 approaches

- By using a single sensor
- array of sensors (sensor strips)
- 2D array of sensors

Ionesian got nobel because of photoelectric effects (from photons to electricity)

- Sensors generates electricity / electrical signal.
- By using single sensor = the sensor can move from front-end & the head can move linearly.
- sensors of strips = In a single go it can move the whole row, like wise, so on. faster than above
- 2D array of sensors = We can have the whole img in a single shot. Every sensors here will generate an electrical signal here (analog signal). the real img is continuous, but the digital img is not continuous. (Boxes have a certain intensity).
Eg = cmos sensor. (Smart phones have these, here sensors are 2D arrays)
- illumination = 0 ⇒ perfect black box.
- $r \neq 1$; ⇒ It can't reflect ~~the~~ lights that more the lights it absorbed, it can't even absorb more lights.

- light calours - Reflects most more lights
- Dark " = Absorbs " "

Img sampling & quantization (analog to digital img)

- Sampling divids the signal into some predefined partitioned.
- The bars will give the impression of the signal.
- The no. are put in the same order
- So we get a 1D array of vals.
- They will give a 2D array, along with the 1D array from 1 row of real img.
- we'll get a digital image

Representing digital images, spatial & intensity resoultion, the eye, Retina up-close, 2 types of light-sensitive receptors, colour image, image pixels, 2 pixels are related (if the intensity of 2 pixels are same), labourwhood, connected component analysis (to read a segment of an img), eg of continuous shots (imgs) taking, addition of 2 images, operations on images

Rep. digital img

- The intensity val.s of the diff. pos of (x,y) are like z-axis & this z-axis will be considered as bars.
- Dark colour = Bar is on x,y plane
- light " = Bar can be seen.

matlab is paid

- Discrete intensity interval [0, L-1], $L = 2^K$ [K bits] → K levels
- K = no. of bits required to store the intensity of the pixel.
- m×N = Dim of pixels / img

eg K = 8 ⟹ we use 8 bits to rep. the intensity of each pixel.

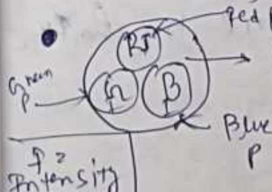
∴ intensity interval = 0 - 255 [$L = 2^K = 256$]

Spatial & intensity resolution

- We rep. resolution in pixels/inch (ppi)
- dots/inch (dpi)

eg 72 ppi or dpi = In 1 area there are 72 no. of pixels.

- Intensity resolution - started with 8 bits...
- Intensity resolution ∝ resolution (upto a certain limit; after that human eyes won't permit)
- sensing = rods & cones cells. → How the sense go to brain through optic nerve, still not found
- extra lense in camera → for rods & cone cell type working.



→ calors img (mixing of calors)

f = intensity

p = phosphor

- illumination material → phosphor
- natural illumator = fireflies.
- energy ∝ glow
- green contributes more to the img. (So the studio by green, bloggers use green screen)

G → R
(40%) (20%)

- the colour imgs are converted to grey scale at 1st then processed.

Another slide (2nd) Study by card

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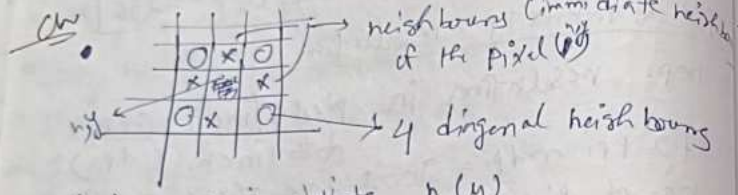
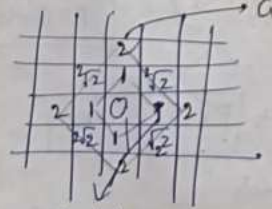


$N_4(P)$ → immidiate n(4)
$N_D(P)$ → digonal n(4)
$N_8(P)$ → total 8 n(8)

- 2 pixels are related if there intensities are same.
- 2 pixels are 4-connected, if their intensity falls in a certain range.

Distance matrix – Euclidean distance, manhattan distance, minkowski.



x diff = 1
y diff = 0

euclidean distance = $\sqrt{(0)^2 + (1)^2}$ = 1.

- thicker distance → longer circle

city clock distance

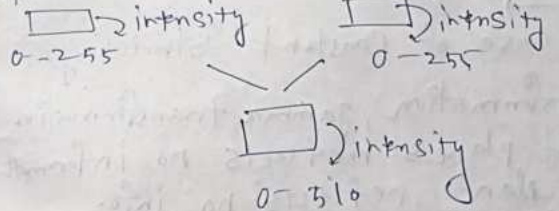
$|x_1 - x_2| + |y_1 - y_2|$

Dg distance or chess board distance

we'll get a square.

add. of 2 mat(:images)

Arithmetic add. b/w 2 images.



(visualization not possible)

- img addition is noice reduction → better quality img
- Some Pix. may have +ive noice, some have -ive noise, when they are added, the img supression happens.

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Image segmentation

segmentation, how we rep points, components

Img

how we can apply diff operations to obtain segmentation.

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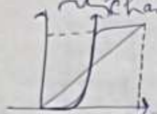
Image segmentation



changes takes place

extreme case of constant stretching.

- log transformation, gamma transformation
- higher bit planes reflects no information
- lower bit plane reflects no info.
- histogram refers to frequencies
- In img, histogram refers to freq of intensities.
- h(rk) → no. of pixel having the intensity rk.
- Histogram Equalization.

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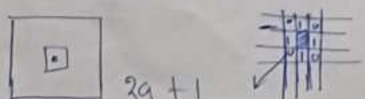
spatial filtering, spatial correlation, S. convolution

- most of the filters use neighbourhood to find the intensity of the pixel.
- Every filter can give an intensity for every pixel



2a+1

-a a W

w2 weights

- The ✩ defines the w (weight) mat: is correlated at the odd position-s of the matrix
- ★ → filled star → convolution
- img chars are better reflected by convolution than correlation.
- W reflects the img chars

Smoothing spatial filters, smoothing linear filters, 2. Smoothing averaging filter masks — we are taking the mean of all of the intensities → it will give blurred img as we are loosing some info as intensities are not proper they are averaged & replaced.

S. lean filters

- D is scaling (Dirameter)

eg, eg: gross rep. of obj, order-statistic (nonlinear) filters, (arrangement of intensities of pixels), eg: use of median filtering for noise reduction, sharpening spatial filters, foundation of sharpening spatial filters; Laplace operator (It is isotropic i.e symmetric), unsharp masking & highboost filtering eg

- median filter is very useful in case of salt & pepper noise reduction.
- Impulse of a signal is sudden change of signal. It is also called impulse noise.

sudden change of +ve dir; sudden change of (-) ve dir

- In this case, impulse noise means sudden

change of intensity.

- sudden change in the (+)ve pixel → salt noise
- sudden change in the -ve are lower part → pepper noise → pepper
- Black obj → salt noise
  light obj (intensity high) → pepper
  (intensity low)
- img averaging makes the img blocked. So, the intensity get reduced.
- sharpening increases the intensity.
- In case img $S(x) = 1$ (change of pos = 1, (no change of pos)).
- 1st order derivative is like speed & 2nd ... acceleration (this happen)
- laplacian operator's eqn can be rep. as a garden in weight (W) matrix.

  (Here we'll use the same convolution principle)

  rest of the weights are 0.

  ↓

  the intensity changes of the img will be sharpening

- Smoothing is opposite of sharpening.

Img sharpening based on 1st-order derivatives eg.

- Here, the gradient signifies the change of intensity along x & y direction. we can rep. gradient as vector.
- The main thing diff. can be seen at the edge of the objs.