영상처리
- Introduction -

디지털 영상처리 개념

디지털 영상처리

- 과거의 아날로그 영상처리 → 광학을 이용한 것
  - 렌즈 굴절률을 이용한 특수 영상 취득, 특수 필터의 광학적 특성 응용
- 디지털 영상처리 → 디지털 영상을 처리하는 학문
- 입력이 영상인 디지털 처리 과정과 시스템을 총칭

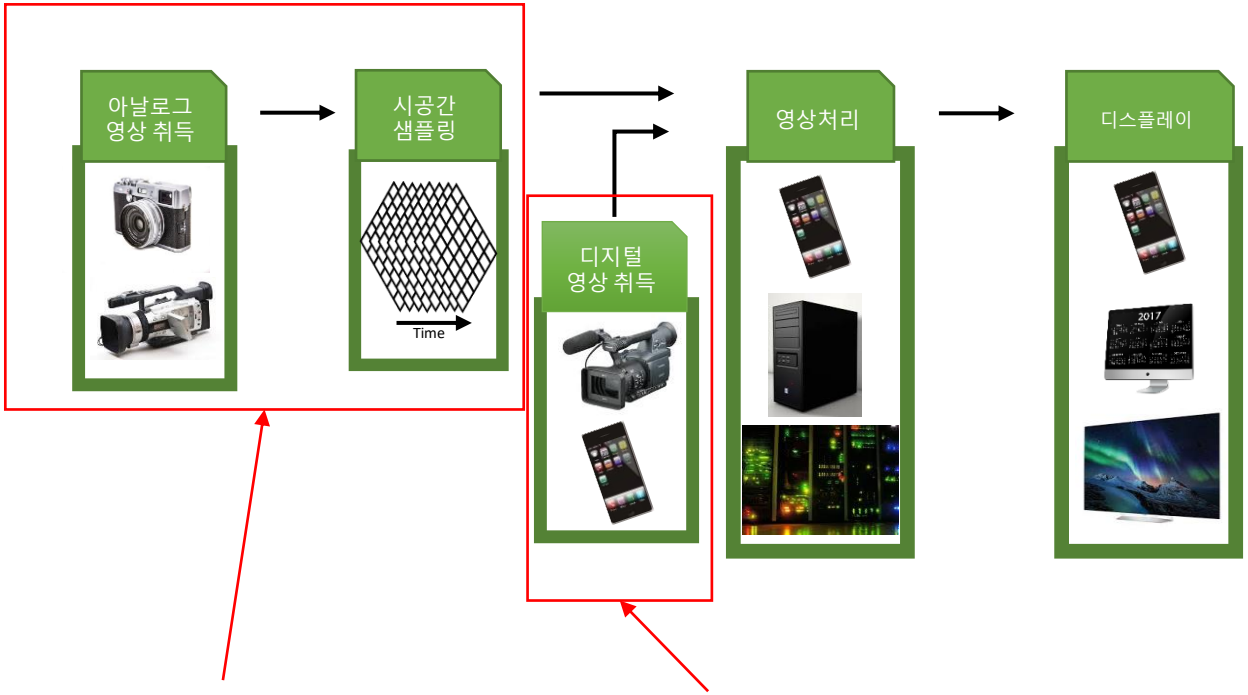
디지털 영상처리 개념

디지털 영상처리

- 현대에는 다양한 영상처리 툴들이 상용화 되어있음
  - 다양한 카메라 어플, 다빈치 디졸브, 프리미어 프로, 파이널 컷 등등
  - 화질 개선, 색 보정, 사진 보정, 영상 편집, 영상 인식 등 모두 영상처리 범주에 들어 감

디지털 영상처리 개념

디지털 영상처리 시스템



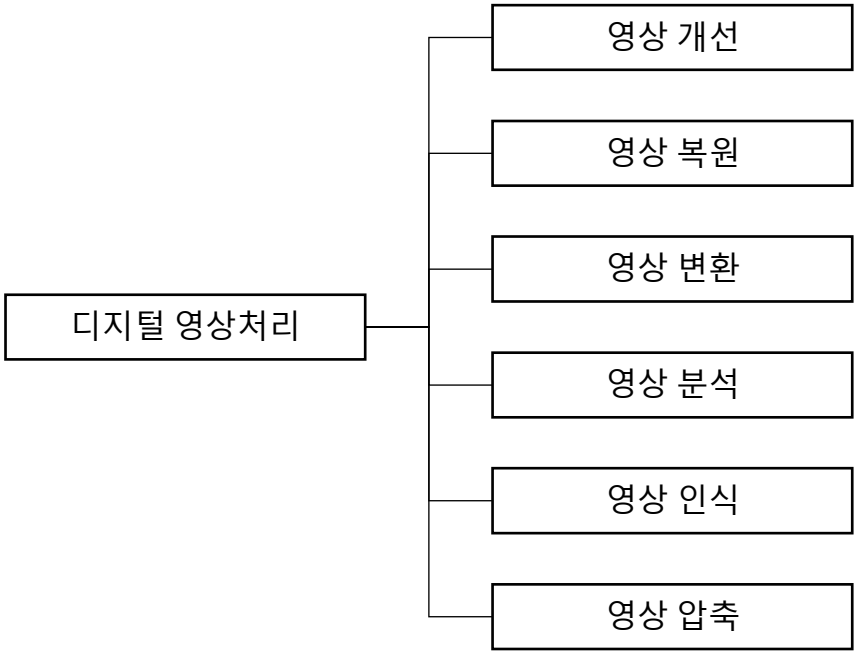
과거:
필름 카메라

현재:
디지털 카메라

영상의 취득, 처리, 재현 및 저장이 용이해짐

디지털 영상처리 분야

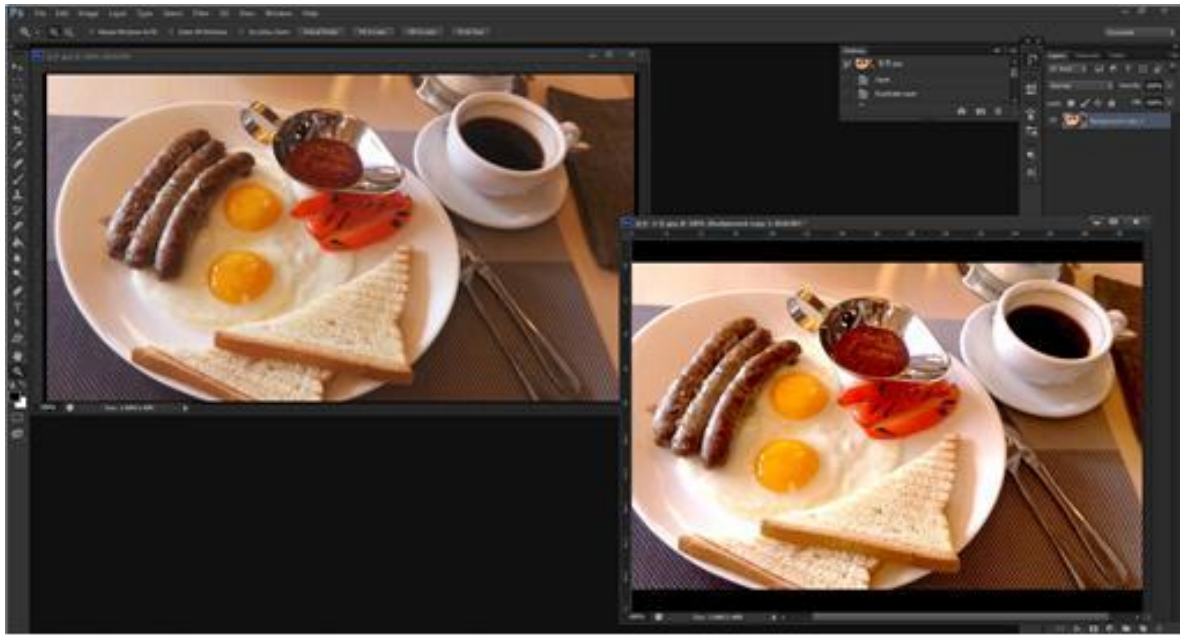
기술분야



디지털 영상처리 분야

영상 개선 (Image enhancement)

- 영상의 화질을 주관적으로 향상 → 보기 좋게 만드는 것
- 사람인 영상을 더 잘 인식하도록 만드는 기술들 (객관적 지표x, 모니터 색 재현율 등 시각 관련 factor들 고려해야함)
- 명암조정, 색 대비 조정, 선명도 조정 등



디지털 영상처리 분야

영상 복원 (Image restoration)

- 객관적인 영상 개선 기술 (손상 복원)
  → 개선에 대한 지표 존재 (원본에 가까울 수록 좋은 기술)

- Noise reduction, aliasing 보정 등

- Noise reduction같은 경우는 source에서 발생할 수 있는 노이즈를 모델링 한 후 노이즈 성분을 제거하는 방식을 많이 사용

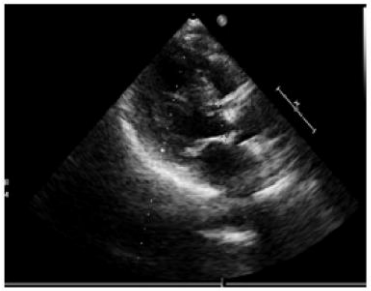


Figure 2. Original Image

Figure 3. Image with Speckle Noise

디지털 영상처리 분야

Lena

- Standard test image for image processing algorithms

IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 5, NO. 1, JANUARY 1996

A Note on Lena

DURING my term as Editor-in-Chief, I was approached a number of times with the suggestion that the IEEE TRANSACTIONS ON IMAGE PROCESSING should consider banning the use of the image of Lena. For those of you who are uninitiated in this brouhaha, let me provide a few facts. The original Lena image was a photograph of a Swedish woman named Lena Sjööblom, which appeared in the November, 1972 issue of *Playboy Magazine*. (In English, Lena is sometimes spelled Lenna, to encourage proper pronounciation.) The image was later digitized at the University of Southern California as one of many possible images for use by the research community. I think it is safe to assume that the Lena image became a standard in our "industry" for two reasons. First, the image contains a nice mixture of detail, flat regions, shading, and texture that do a good job of testing various image processing algorithms. It *is* a good test image! Second, the Lena image is a picture of an attractive woman. It is not surprising that the (mostly male) image processing research community gravitated toward an image that they found attractive. The Woody Allen buffs among you may be interested to know that the Lena image appeared in the movie *Sleeper*. Tom Huang pointed this out to me. In the scene where Allen awakes in the year 2173, he is asked to identify a number of artifacts from the past, including photographs of Joseph Stalin and Charles de Gaulle, and the issue of *Playboy Magazine* containing Lena. The view to the movie watcher is fleeting and somewhat unclear, but this is the closest I have come to viewing the original image. From second-hand reports from Sweden, I am told that Lena is living in a small town south of Stockholm. She is said to be quite amazed that her image has become a standard in the research community. In recent years, Playboy Enterprises was giving thought to enforcing their copyright on the Lena image (see Brian Thompson's editorial in the January 1992 issue of *Optical Engineering*). It appears, though, that this is no longer the case.

So what is the problem? Well, quite understandably, some members of our community are unhappy with the *source* of the Lena image. I am sympathetic to their argument, which states that we should not use material from any publication that is seen (by some) as being degrading to women. I must tell you, though, that within any single segment of our community (e.g., men, women, feminists), there is a complete diversity of opinion on the Lena issue. You may be surprised to know that most persons who have approached me on this issue are male. On the other hand, some informal polling on my part suggests that most males are not even aware of the origin of the Lena image! I have heard feminists argue that the image should be retired. However, I just recently corresponded with a feminist who had a different point of view. She was familiar with the Lena image, but she had not imagined that there could be any controversy. When I offered an explanation of why some persons are offended by the use of the image, she responded tartly. A watered-down version of her reply is, "There isn't much of Lena showing in the Lena image. This political correctness stuff infuriates me!"

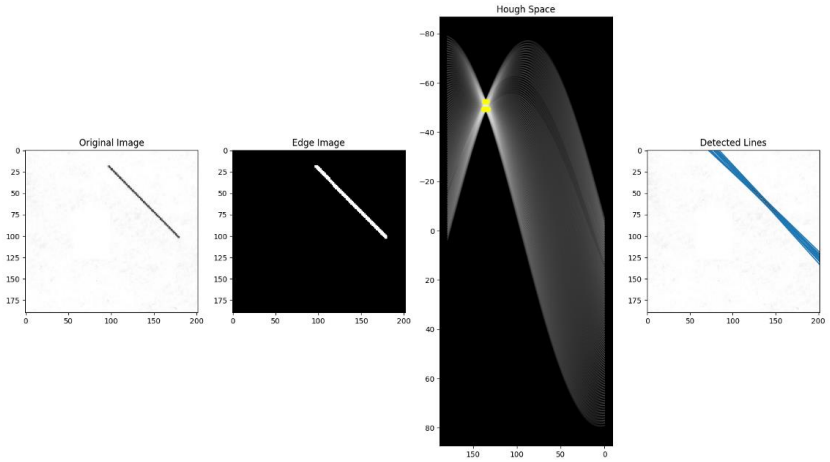
So there you have it. Much of our community is blind to the fact (until now!) that there is a controversy. Among those who are "tuned in," there is vigorous disagreement. As Editor-in-Chief, I did not feel that this issue warranted the imposition of censorship, which, in my view, should be applied in only the most extreme circumstances. In addition, in establishing the precedent, I was not sure where this might lead. Should we ban the Cheerleader video sequence? Should we establish an oversight panel to rule on acceptable imagery? Instead, I opted to wait and see how the situation might develop. I suspected that the use of Lena would decline naturally, as diverse imagery became more widely available and as the field of image processing broadened in scope. Although the use of Lena *has* declined (witness our January, 1992 issue!), this image still appears so frequently that I imagine it must be grating on those who oppose its use. What to do? I favor a compromise of sorts. I suggest that the IP authorship be more sensitive to the feelings of those who are offended by the Lena image. In cases where another image will serve your purpose equally well, why not use that other image? After all, why needlessly upset colleagues? And who knows? We may even devise image compression schemes that work well across a broader class of images, instead of being tuned to Lena!

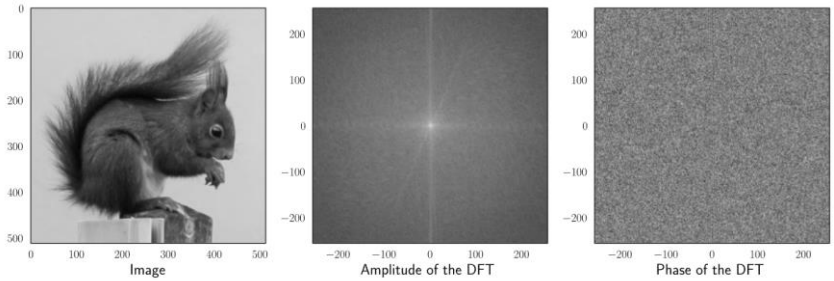
DAVID C. MUNSON, JR.
Editor-in-Chief, Emeritus

디지털 영상처리 분야

영상 변환 (Image transformation)

- 다른 영상처리 목표를 위해 거쳐가는 중간단계의 의미가 큼
- 예) 물리적 공간 → 주파수 공간 으로의 변환 (Fourier transform, image frequency 응용)
- 예) 방향 성분 추출 변환 (Hough transform)
- 예) 물리적 공간 내에서의 변환 (회전, 이동, 기울임 등)





디지털 영상처리 분야

영상 분석 (Image analysis)

- Quantitative analysis의 의미가 큼
- 영상의 특성을 수치화 하여 인식, 예측 등에 활용
- 구조적 특징, 통계적 특징 등을 이용

영상 인식 (Image recognition)

- 영상 분석의 확장된 개념
- 인식 과정에 영상 복원, 변환, 개선 등의 과정이 포함될 수 있음
- 사물 인식, 지문 인식, 얼굴 인식 등등
- 영상을 분석하여 원하는 조건에 맞는 의미있는 정보를 추출하거나 분류하는 과정

디지털 영상처리 분야

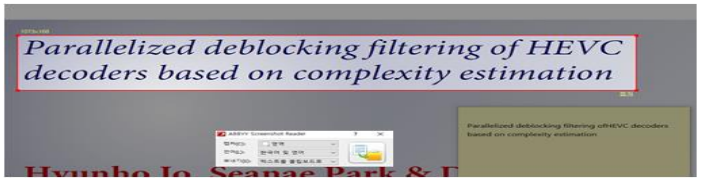
영상 압축

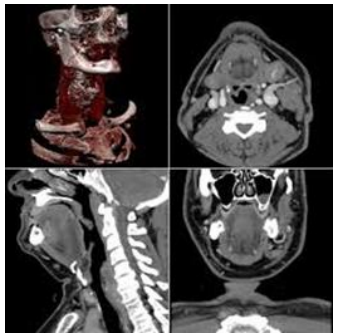
- 영상의 용량 – 픽셀 수, 밝기값의 범위에 비례
- 데이터를 효율적으로 저장하는 기술
- {200, 199, 205, 210, 215} → {200, -1, 6, 5, 5}로 저장하면, 데이터를 표현하는 데에 필요한 비트량 감소

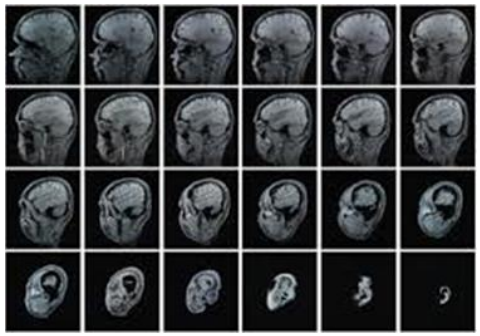
디지털 영상처리 분야

활용 분야

- 영생 재생 장치
- 디지털 카메라
- 생체인식
- 차량 번호 인식
- 문자인식 (OCR)
- 의료영상



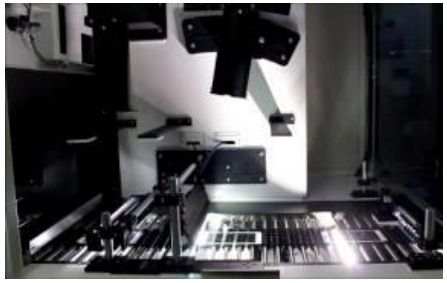
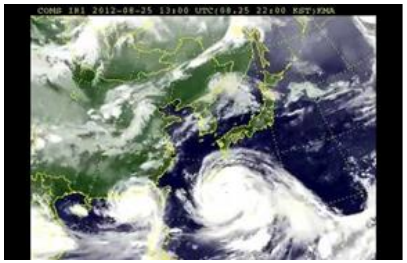




디지털 영상처리 분야

활용 분야

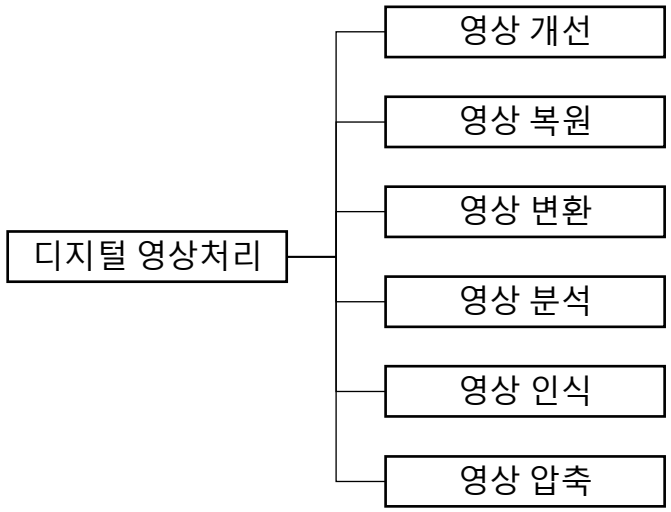
- 공장 자동화
- 위성 영상
- 지능형 감시카메라
- 인터랙티브 게임
- 무인 자동차

디지털 영상처리 분야

기술분야

정통 영상처리 분야



딥러닝 영상처리 분야

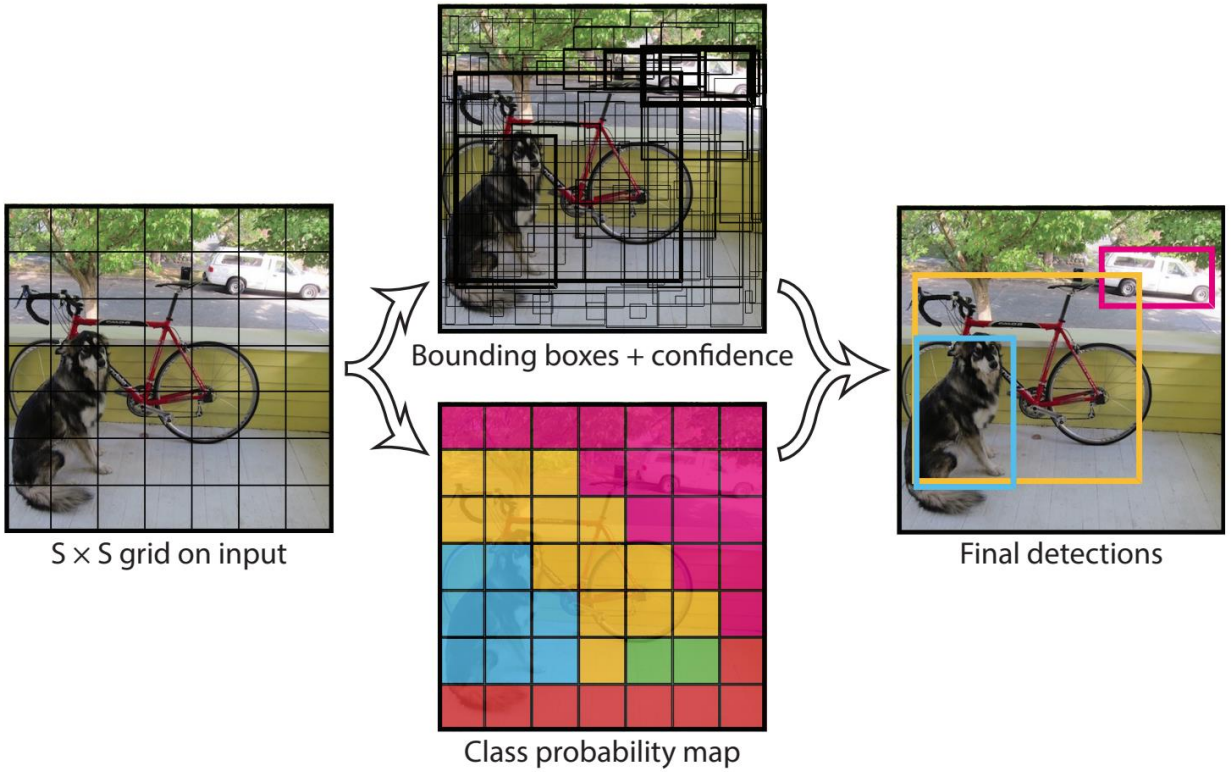
- 영상 개선, 복원
  - U-net기반 구조, Diffusion modeling (DALLE-2)
- 영상 합성
  - Diffusion modeling, Generative adversarial network
- 영상 인식
  - 분류: CNN기반 network들
  - 객체 탐지: Yolo, fast R-CNN
- 영상 분할 (segmentation)
  - U-net 기반 구조, R-CNN 등
- 응용
  - Text to image, Image to text Transformer (GPT) + DALLE-2

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- VOLO v4 – 사물 감지 및 분류 모델

https://www.youtube.com/watch?v=1_SiUOYUoOI&ab_channel=goodrest



디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- 자율주행 – 차선 및 물체 감지

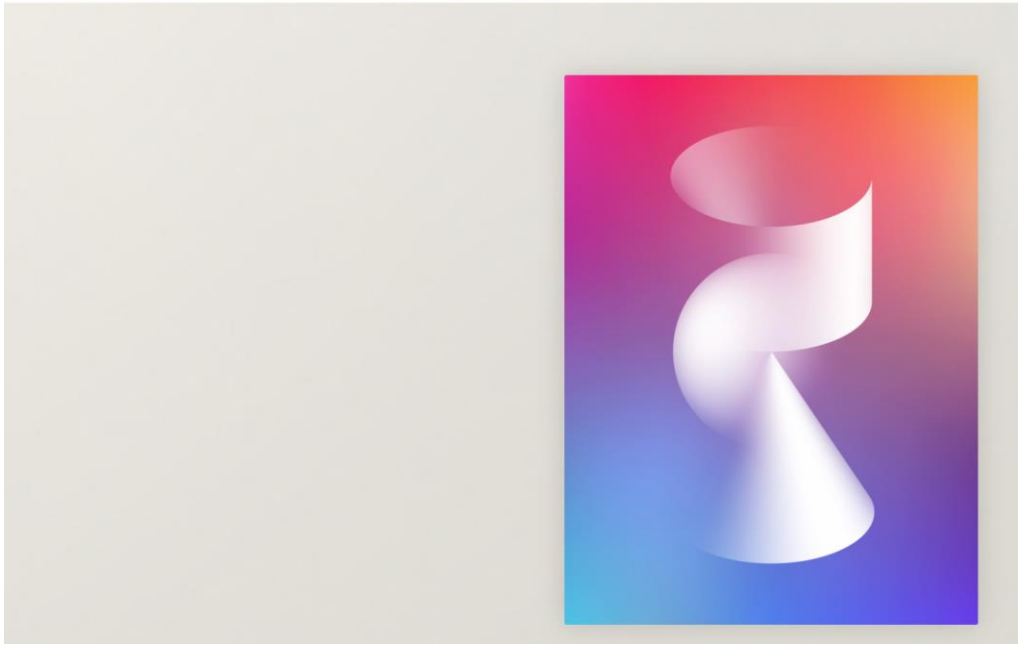
https://www.youtube.com/watch?v=FdZvMoP0dRU&ab_channel=TawnKramer

디지털 영상처리 분야

딥러닝 영상처리 적용 예시 (자연어 처리 + 영상 딥러닝)

- Text context해석 및 시각 정보 합성 (DALLE) **(자연어 처리 + 영상 딥러닝)**
  - https://openai.com/dall-e-2/
  - **OPEN AI → 비영리 초거대 AI 공개 연구 플랫폼**

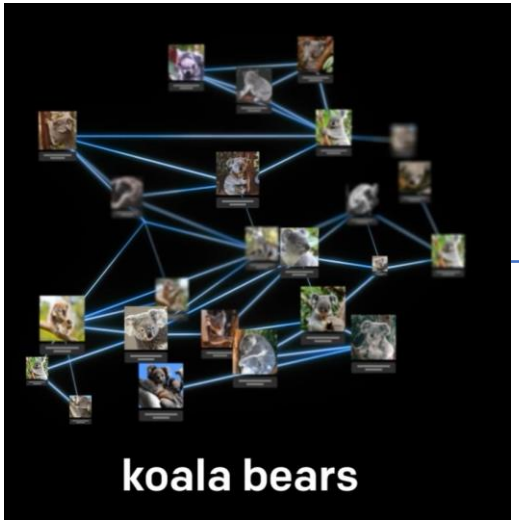
OpenAI is an AI research and deployment company. Our mission is to ensure that artificial general intelligence benefits all of humanity.



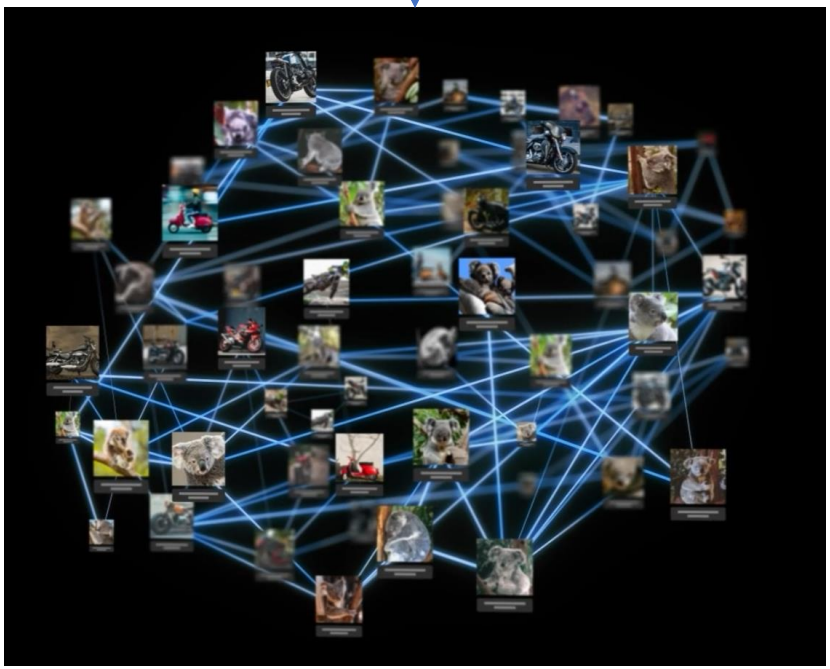
디지털 영상처리 분야

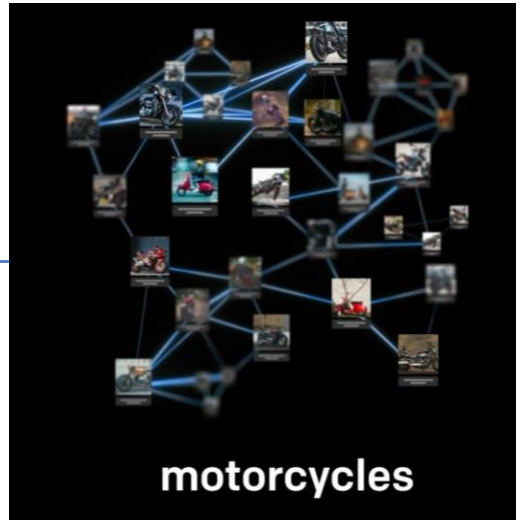
딥러닝 영상처리 적용 예시

- Text context해석 및 시각 정보 합성 (DALLE) **(자연어 처리 + 영상 딥러닝)**



단어와 시각정보 사이의
연관관계 학습





디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- Text context해석 및 시각 정보 합성 (DALLE) **(자연어 처리 + 영상 딥러닝)**

Teddy bears mixing sparkling chemicals as mad scientists as digital art
테디베어가 부글부글 끓는 화학물을 과학자처럼 섞고 있는 것을
디지털 아트 형식으로 그려줘

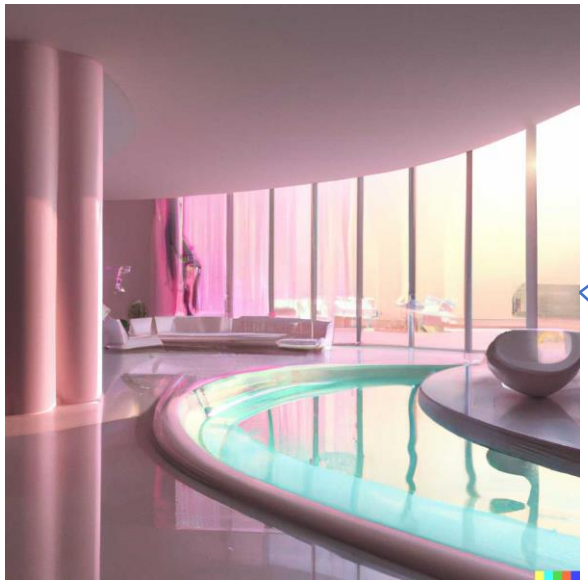


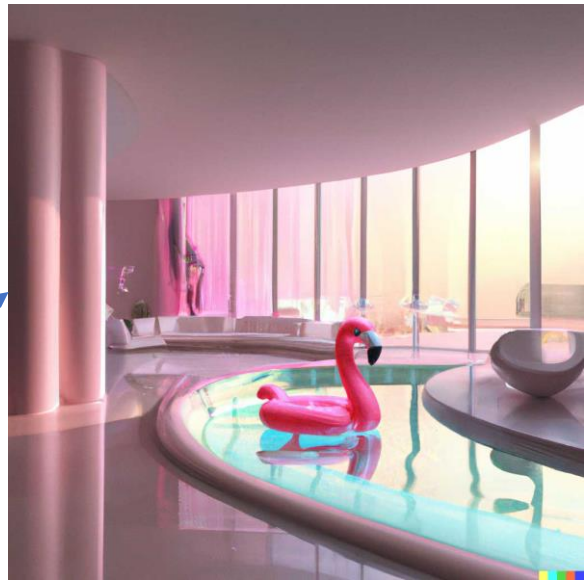
디지털 영상처리 분야

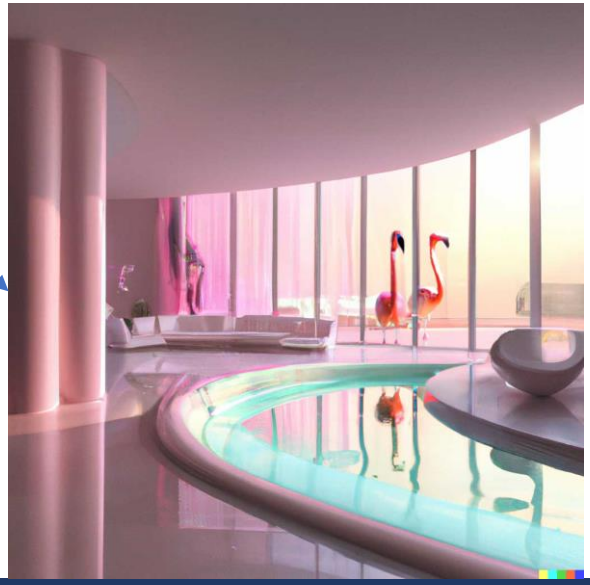
딥러닝 영상처리 적용 예시

- Text context해석 및 시각 정보 합성 (DALLE)

사진에 홍학을 넣어줘



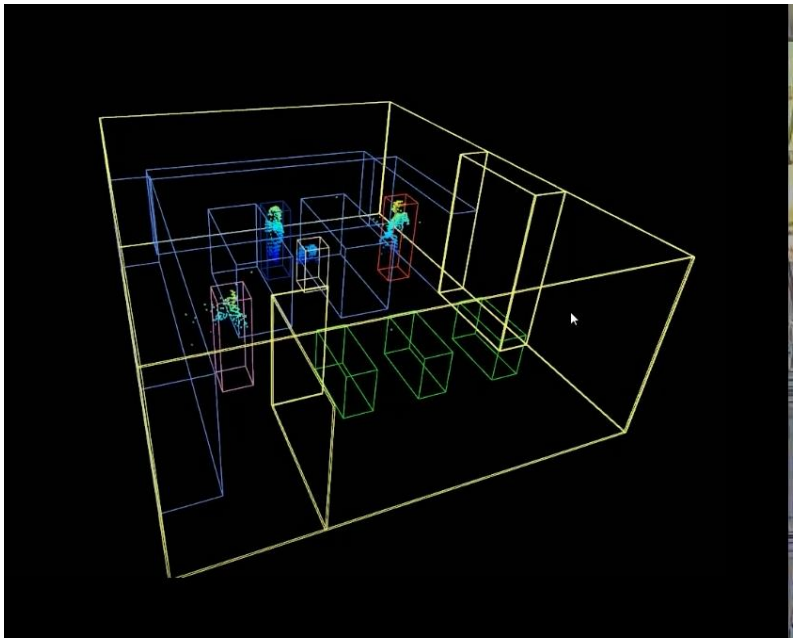


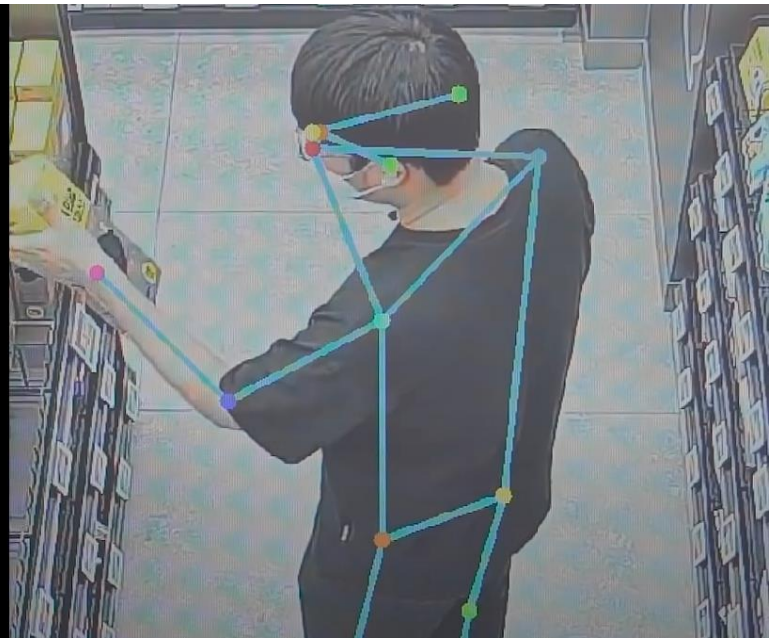


디지털 영상처리 분야

딥러닝 영상처리 적용 예시 (영상 + 여러정보)

- 인공지능 무인편의점
- https://www.youtube.com/watch?v=GIydfp-vtng





디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- **얼굴 합성 (StarGAN)**

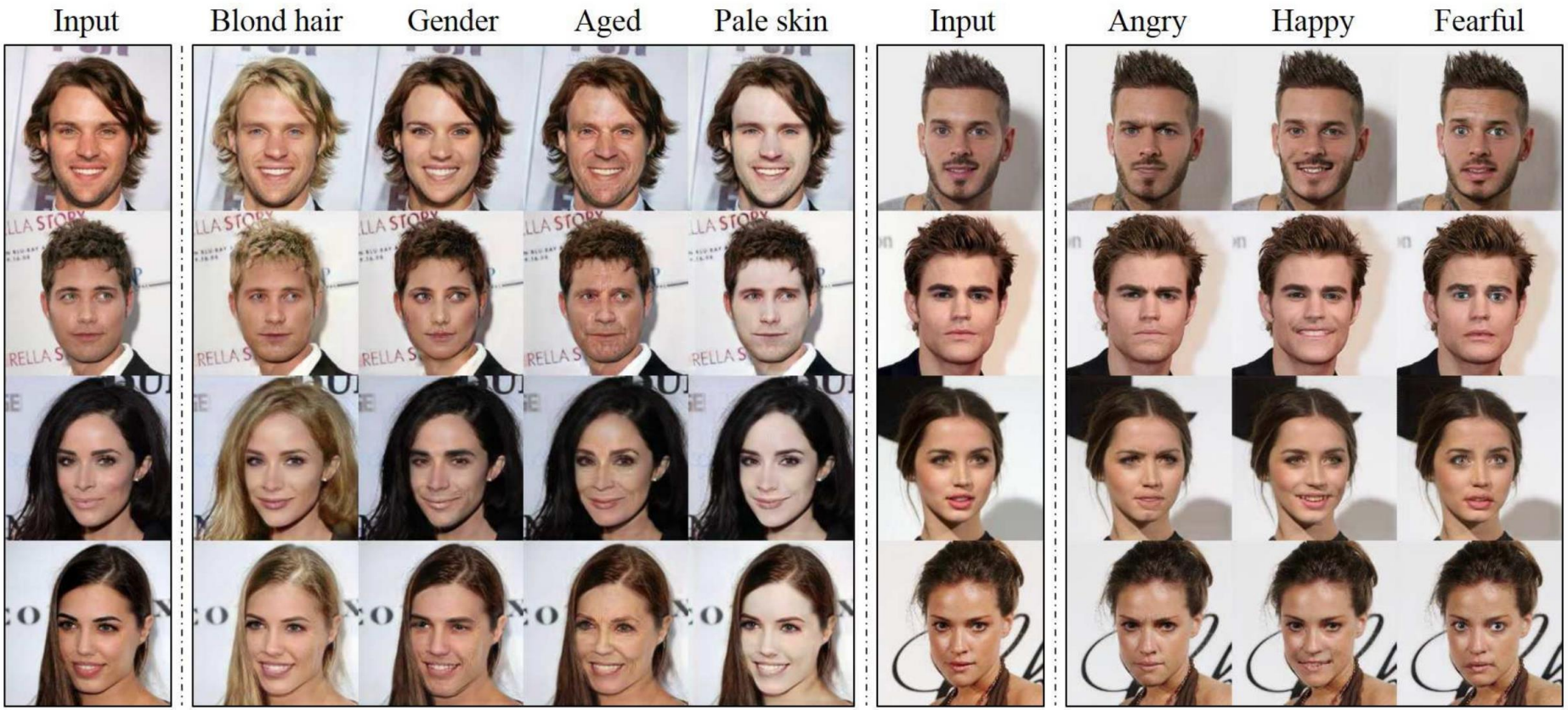


Figure 1. Multi-domain image-to-image translation results on the CelebA dataset via transferring knowledge learned from the RaFD dataset. The first and sixth columns show input images while the remaining columns are images generated by StarGAN. Note that the images are generated by a single generator network, and facial expression labels such as angry, happy, and fearful are from RaFD, not CelebA.

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

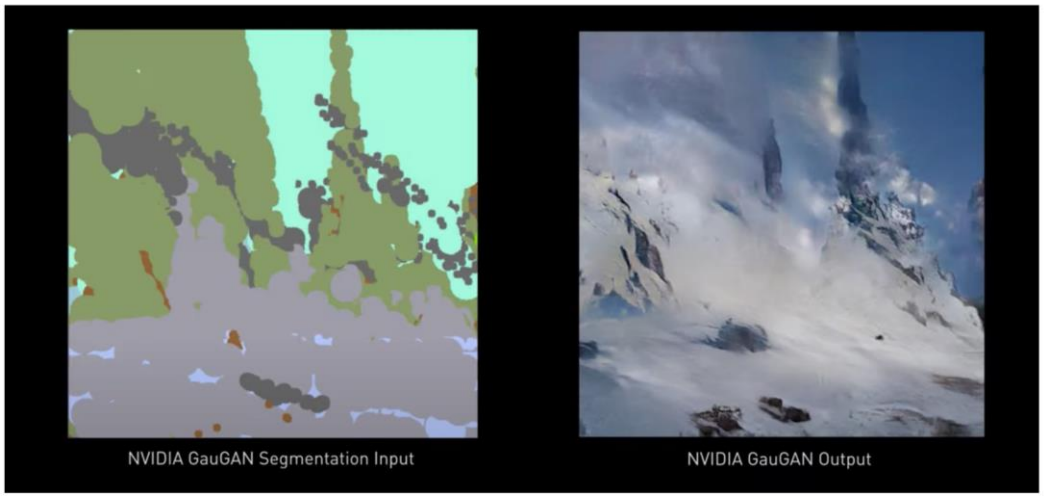
Contents generation

Representation learning

CVPR 2022 lecture note

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

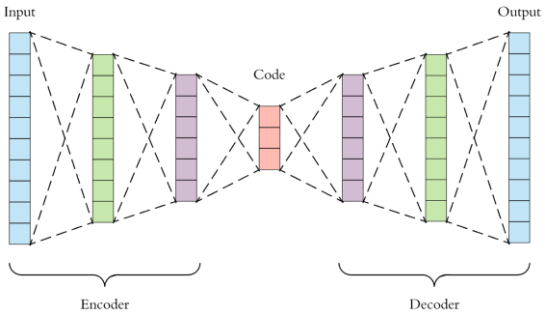


Artistic tool

CVPR 2022 lecture note

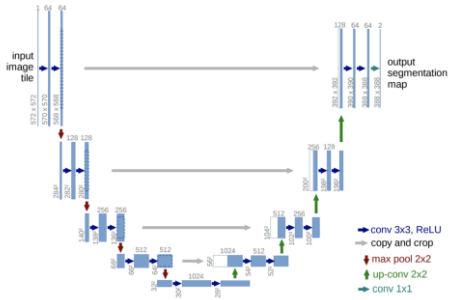
디지털 영상처리 분야

딥러닝 영상처리 적용 예시



Autoencoder (AE)
Denoising AE
Sparse AE
Variational AE

U-net



R2 U-net

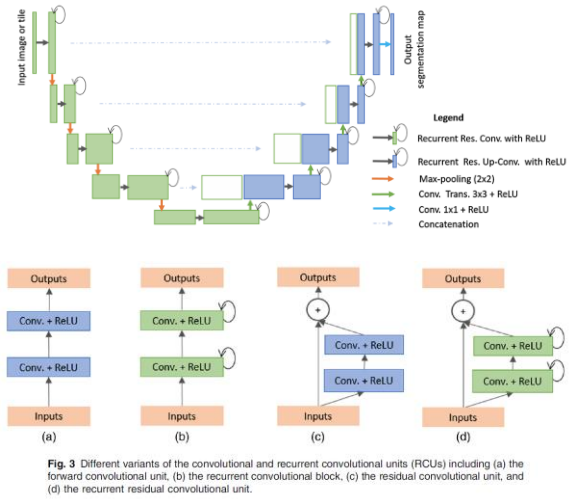
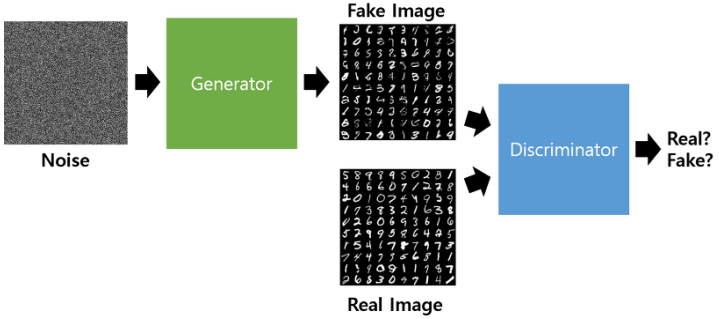


Fig. 3 Different variants of the convolutional and recurrent convolutional units (RCUs) including (a) the forward convolutional unit, (b) the recurrent convolutional block, (c) the residual convolutional unit, and (d) the recurrent residual convolutional unit.

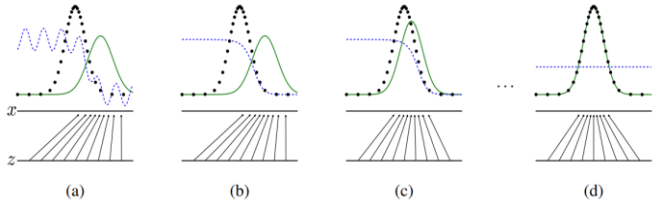
디지털 영상처리 분야

딥러닝 영상처리 적용 예시

Generative adversarial network (GAN)



DCGAN: Convolution 적용
LSGAN: Least Square loss적용
PGGAN: Progressive growing적용
CycleGAN: 역변환 가능한 모델
StarGAN: Domain Transfer
SRGAN: 고화질 이미지 생성
SytleGAN …



$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x}\sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z}\sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))].$$

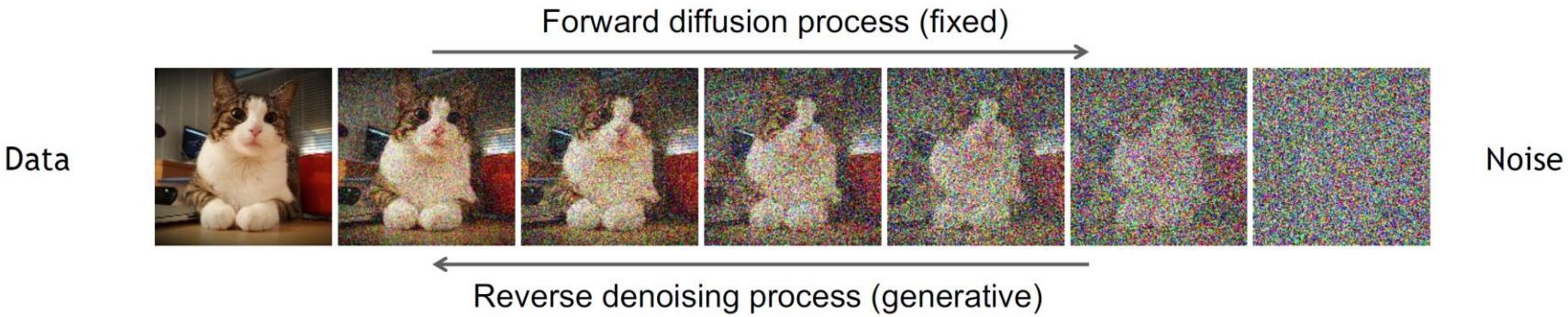
Real data classification　　Fake data classification

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

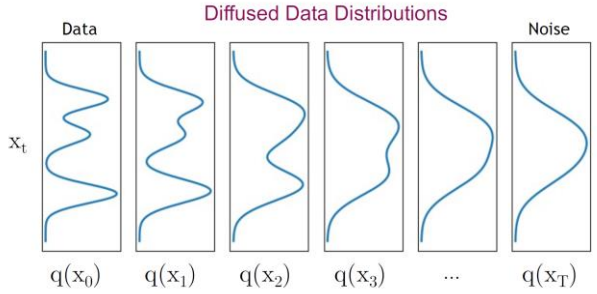
Denoising diffusion models consist of two processes:

- Forward diffusion process that gradually adds noise to input
- Reverse denoising process that learns to generate data by denoising



$$\underbrace{q(\mathbf{x}_t)}_{\text{Diffused data dist.}} = \int \underbrace{q(\mathbf{x}_0, \mathbf{x}_t)}_{\text{Joint dist.}} d\mathbf{x}_0 = \int \underbrace{q(\mathbf{x}_0)}_{\text{Input data dist.}} \underbrace{q(\mathbf{x}_t|\mathbf{x}_0)}_{\text{Diffusion kernel}} d\mathbf{x}_0$$

The diffusion kernel is Gaussian convolution.

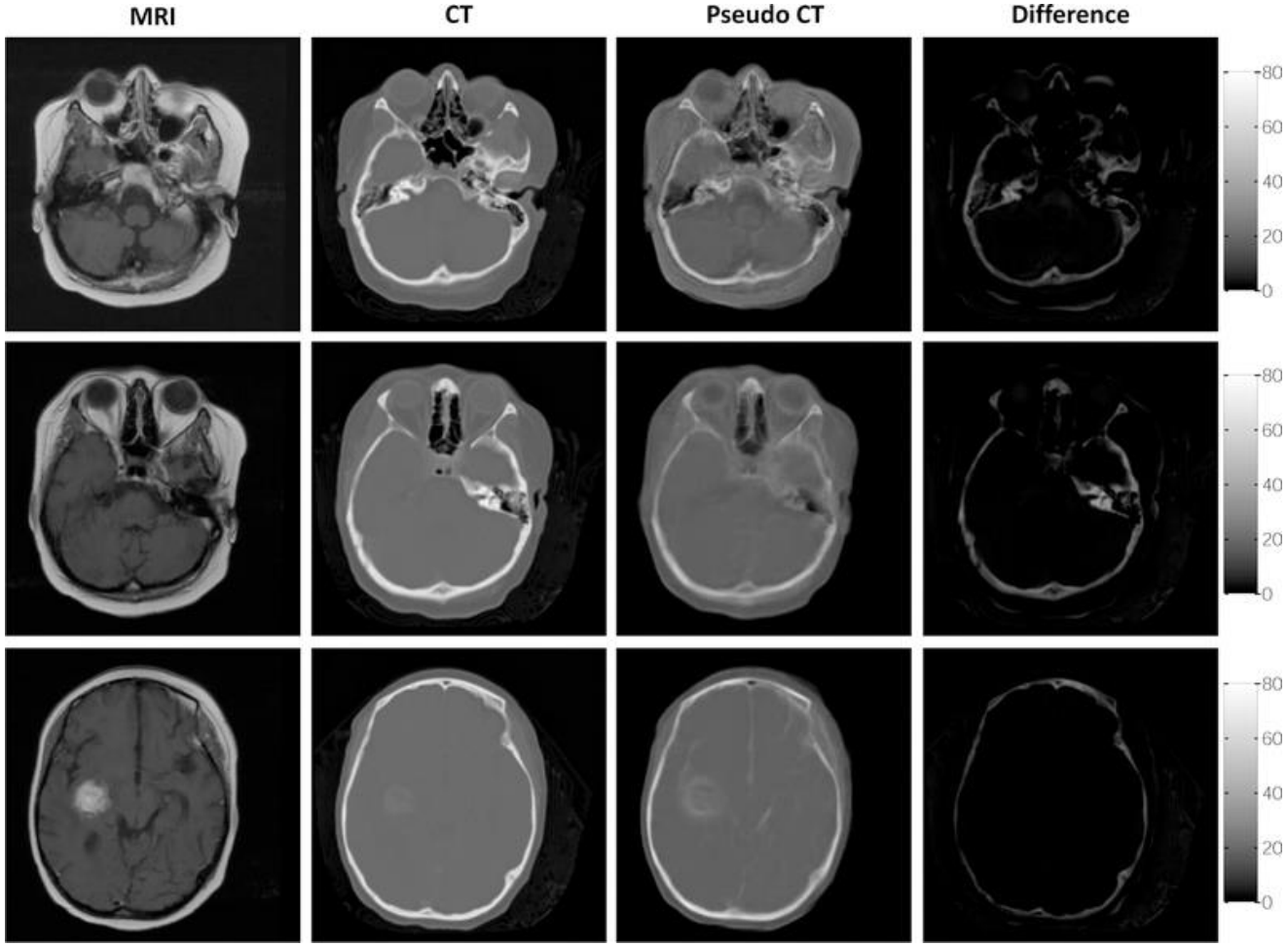


CVPR 2022 lecture note

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- 의료영상 합성

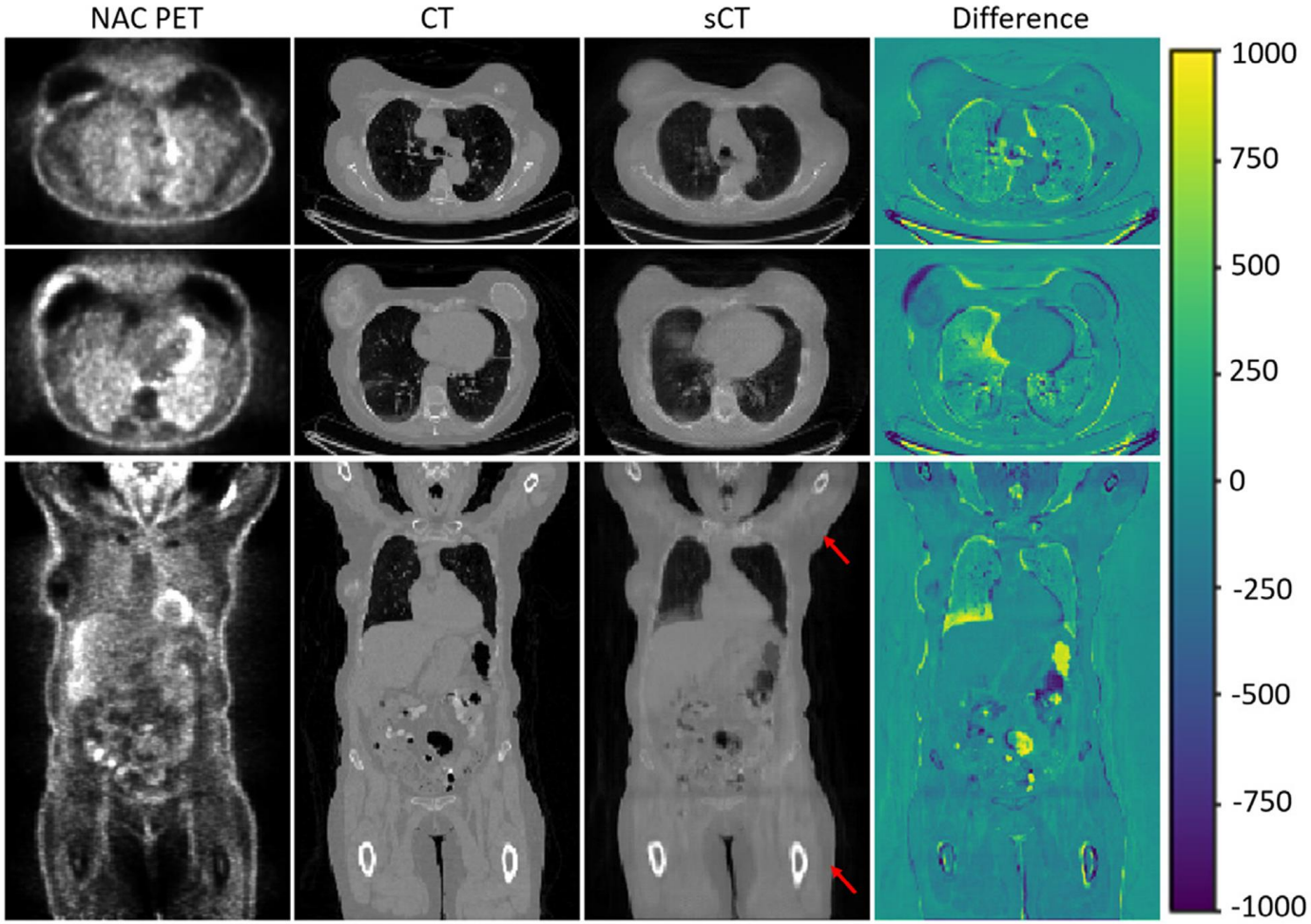


→ MR images has more nice soft tissue contrast
→ CT image are used to calculate density map, reference image
→ Can be used to do Radiation Therapy planning

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

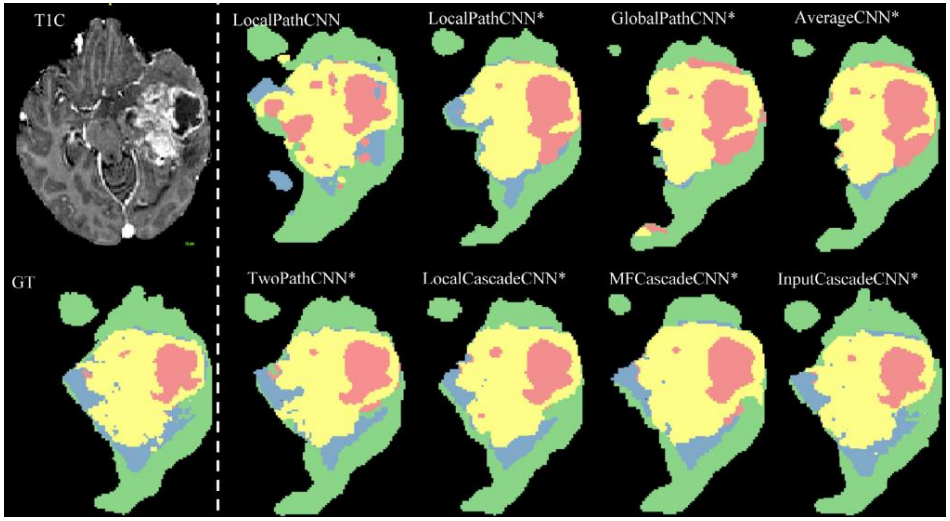
- 의료영상 합성

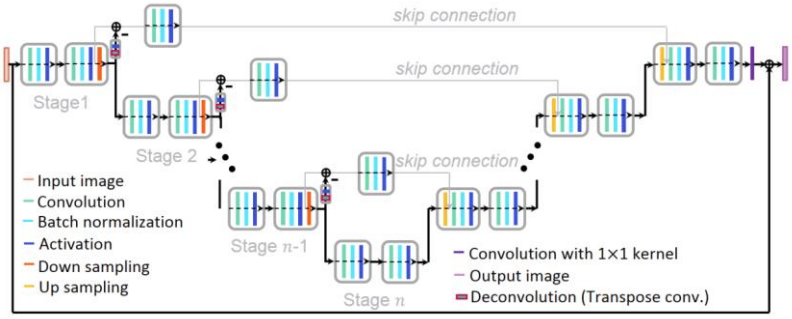


디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- 병변 segmentation



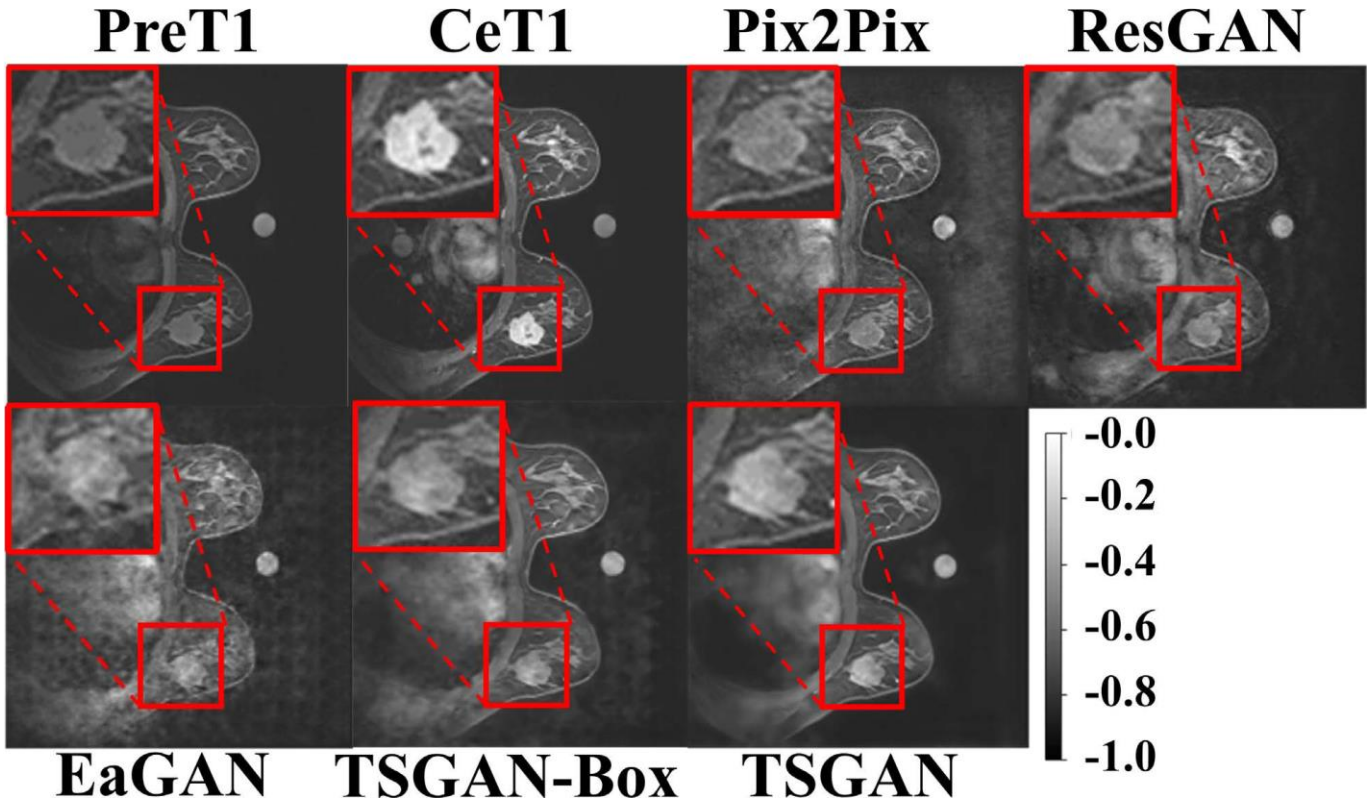


Havaei, Mohammad, et al. "Brain tumor segmentation with deep neural networks." Medical image analysis 35 (2017): 18-31.
Seo, Hyunseok, et al. "Modified U-Net (mU-Net) with incorporation of object-dependent high level features for improved liver and liver-tumor segmentation in CT images." IEEE transactions on medical imaging 39.5 (2019): 1316-1325.

디지털 영상처리 분야

딥러닝 영상처리 적용 예시

- 조영증강 simulation



Kim, Eunjin, et al. "Tumor-Attentive Segmentation-Guided GAN for Synthesizing Breast Contrast-Enhanced MRI Without Contrast Agents." IEEE Journal of Translational Engineering in Health and Medicine 11 (2022): 32-43.,