Current Status of the JSRT and AI Research in the Field of Medical Imaging

Takayuki Ishida, Ph.D.

Japanese Society of Radiological Technology
Representative Director (President)

Department of Health Sciences,
Osaka University

Current Status of the JSRT

and

AI Research in the Field of Medical Imaging

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Resume

Takayuki Ishida, Ph.D.

WORK EXPERIENCE

- 2012 ～ Professor in Osaka University
- 2005 ～ 2012 Professor in Hiroshima International University
- 1998 ～ 2005 Associate Professor in Hiroshima International University
- 1994 ～ 1998 Research Associate in the University of Chicago
- 1986 ～ 1994 Radiological Technologist in Osaka Central Hospital
- 1983 ～ 1986 Radiological Technologist in Muikaichi Hospital

OFFICIAL POSITION

- 2023～ Representative Director of the Japanese Society of Radiological Technology (JSRT)
- 2023～ Advisor of Medical Imaging and Information Sciences (MII)
- 2020～ Vice Dean of Division of Health Sciences, Department of Medicine, Osaka University

EDUCATION

- 1993 Obtained Doctorate in Engineering from Ritsumeikan University
- 1983 Graduated from College of Biomedical Technology Osaka University

SPECIALIZED FIELD

- Artificial Intelligence
- Computer-Aided Detection and/or Diagnosis (CADe, CADx)
- Medical Image Analysis and Processing
- Medical Imaging Technology

JSRT Administrators 2023・2024

Administrator	Name	Administrator	Name
President	Takayuki Ishida	Director	Rie Tanaka
Vice-president	Yasuo Okuda	Director	Mitsuhiro Nakamae
Vice-president	Takao Ichida	Director	Hiroko Nishide
Vice-president	Toru Negishi	Director	Eiji Nishimaru
Director	Takashi Iimori	Director	Kohei Harada
Director	Hideyuki Iwanaga	Director	Kosuke Matsubara
Director	Koji Uchida	Director	Noriyuki Yanagawa
Director	Hidemichi Kawata	Director	Seiji Yahata
Director	Koji Koizumi	Director	Takayoshi Yamaguchi
Director	Shigeyoshi Saito	Auditor-secretary	Hiroshi Hirano
Director	Junji Shiraishi	Auditor-secretary	Masao Funahashi

President’s Statement of Beliefs

- Encouraging interdisciplinary research
- Collaboration and partnerships with international organizations
- Quality basic education
- Training of young researchers

● Encouraging interdisciplinary research

Recent advances in artificial intelligence (AI), 4K/8K video technology, AI using quantum computers, and faster Monte Carlo simulations will surely lead radiology technology to unprecedented advances. I would like everyone to have a broad perspective, be interested in different fields, and strive to create an environment in which they can learn new knowledge and technology.

Joint research by multiple specialized subcommittees is important to create a system incorporating advanced external technology and knowledge for radiological technology.

I strongly hope that each specialized subcommittee will promote innovative research, publish more papers than ever, and become the driving force behind creating trends.

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- Collaboration and partnerships with international organizations

We hold study groups and academic conferences overseas in collaboration with Asian countries that provide educational and research support, as well as overseas academic societies with which we have MOU, and hold related international academic conferences in Japan. By holding the conference jointly, we would like to promote mutual academic development and deepen our friendship.

- Quality basic education

I would like to place emphasis on education because the knowledge that members gain through excellent education will definitely be useful in research and clinical practice. To this end, we would like to create an environment where all members can learn systematically, including enriching the educational syllabus and linking each item to content.

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- Training of young researchers

Nurturing young researchers is extremely important for the continued development of radiological technology and for the future development of academic societies. Local branches have played this role up until now, but I would like to see them work harder than ever to develop young people.

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Radiological Physics and Technology, since 2008

Radiological Physics and Technology covers multiple disciplines involved in basic research and clinical applications in radiological sciences. The multidisciplinary research in medical physics and radiological technology as well as the promotion of research efforts in new scientific fields will be facilitated by the journal's editorial policy, which will also aim to promote translational research in this field.

Radiological Physics and Technology, since 2008

Quarterly publication since 2017

- Provides an ideal forum for sharing new knowledge related to research and development in radiological science and technology
- Contributes to progress and improvement in medical practice and patient health care.
- The official journal of the Japanese Society of Radiological Technology (JSRT) , the Japan Society of Medical Physics (JSMP), and the Asia-Oceania Federation of Organizations for Medical Physics (AFOMP)

RPT obtained Journal Impact Factor in 2023

Editor-in-Chief

Nobuyuki Kanematsu

1.6 (2022)

Impact factor

1.8 (2022)

Five year impact factor

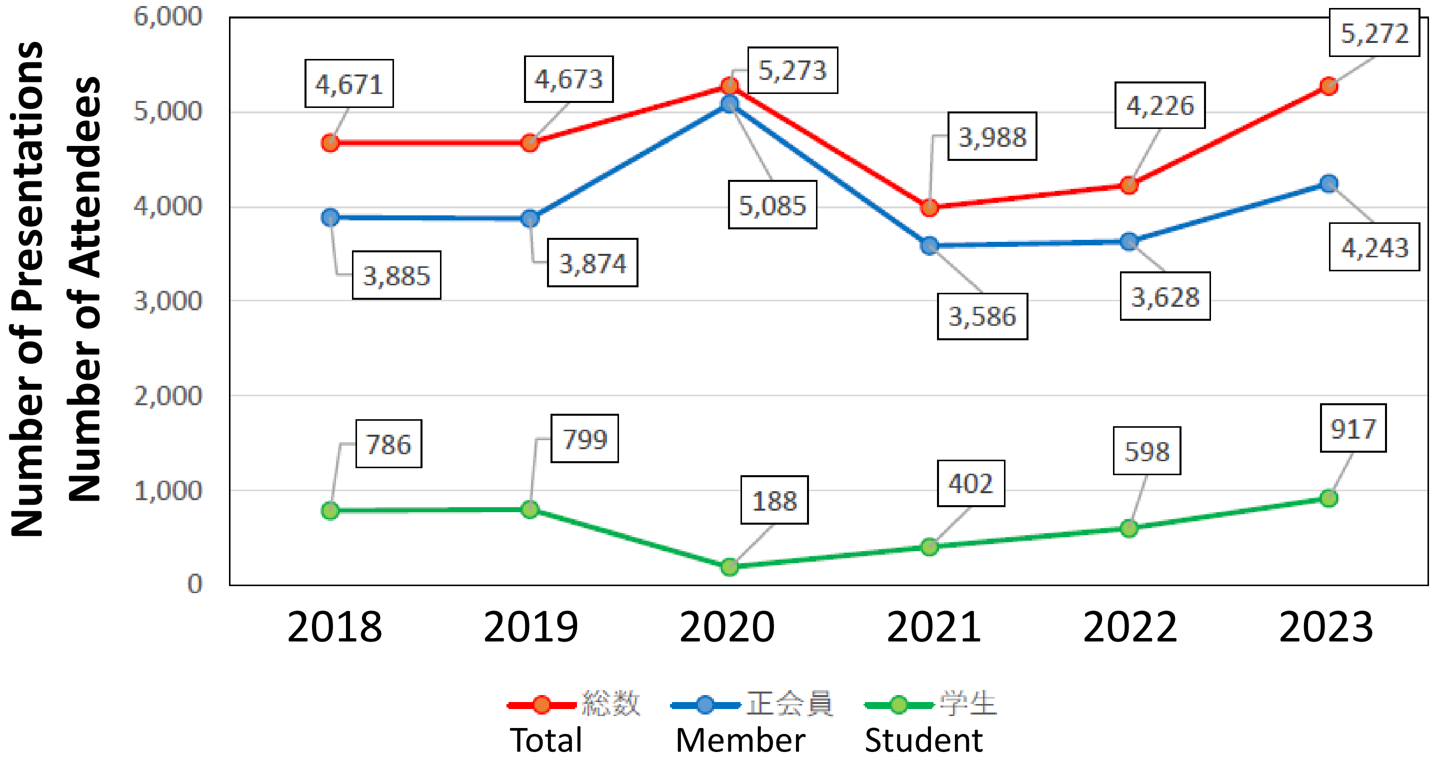
7 days

Submission to first decision (Median)

Number of presentations and attendees at scientific congress

	Annual Meeting			Autumn Meeting		
	host city	# of Papers	Attendees	host city	# of Papers	Attendees
2018	Yokohama	546	4728	Sendai	456	1785
2019	Yokohama	539	4737	Osaka	387	2054
2020	Yokohama	498	5273	Tokyo	-	-
2021	Yokohama	332	3988	Kumamoto	331	2409
2022	Yokohama	326	4226	Tokyo	260	2048
2023	Yokohama	488	5272	Nagoya	**332**	**2305**
2024	Yokohama	**485**				

Number of presentations and attendees at the annual congress (JRC)



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Japan Society of Medical Physics

ICRPT
International Conference on Radiological Physics and Technology

Japanese Society of Radiological Technology

Welcome to the 3rd ICRPT !
The 3rd ICRPT will be held in the JRC2024

Date: April, 11-14, 2024
Venue: Pacifico Yokohama ,
Yokohama, Japan
Conference President: Negishi Toru (JSRT)
Masayori Ishikawa (JSMP)

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Academic congress JCRTM2024 will be held at Okinawa

The 1st Japanese Congress of Radiological Technology in Medicine (JCRTM2024) will be held jointly with the Japan Association of Radiological Technologists (JART) in 2024.

- Conference: The 1st Japan Congress of Radiological Technology in Medicine
- Hosted: The 40th Japanese Association of Radiological Technologist Academic Conference, The 52nd Japanese Society of Radiological Technology Autumn Congress
- Meeting period: October 31st (Thursday) to November 3rd (Sunday), 2024
- Venue: Okinawa Convention Center: 4-3-1 Mashiki, Ginowan City, Okinawa
- Theme: Yuimar ~Co-creation of medical radiological technology~
- Chairman: Junji Shiraishi (JSRT) , Katsuhiko Ueda (JART)

Current Status of the JSRT
and
AI Research in the Field of Medical Imaging

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applied sciences

Development of Artificial Intelligence-Based Dual-Energy Subtraction for Chest Radiography

by Asumi Yamazaki [1,†], Akane Koshida [1,†], Toshimitsu Tanaka [2], Masashi Seki [3] and Takayuki Ishida [1,*]

[1] Division of Health Sciences, Graduate School of Medicine, Osaka University, Suita 565-0871, Japan
[2] Department of Radiology, National Cerebral and Cardiovascular Center, Suita 564-8565, Japan
[3] Department of Radiology, Kitasato University Hospital, Sagamihara 252-0329, Japan
[*] Author to whom correspondence should be addressed.
[†] These authors contributed equally to this work.

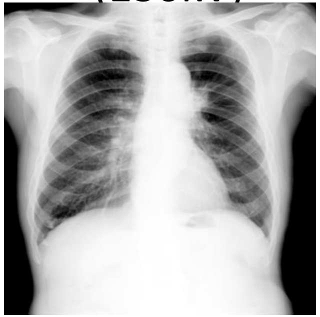
Appl. Sci. **2023**, *13*(12), 7220; https://doi.org/10.3390/app13127220

Submission received: 17 May 2023 / Revised: 9 June 2023 / Accepted: 15 June 2023 / Published: 16 June 2023

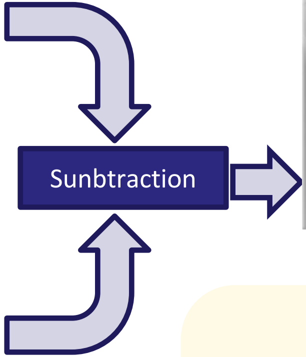
Background

DES (dual energy subtraction) method

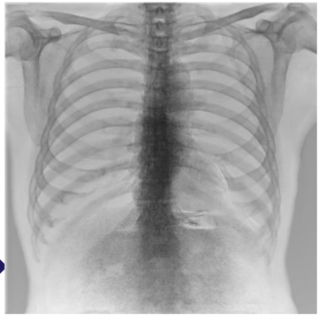
High Energy
(130kV)



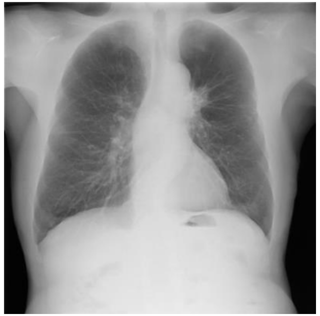
Low Energy
(60kV)



Bone image



Soft-tissue image



Problems

- Single-shot : Detector sandwiching Cu plate
  ⇒ ***limited facilities, Increased noise***
- Dual-shot : Two X-rays required
  ⇒ ***Increased exposure, artifacts***

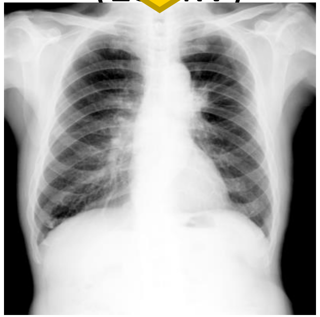
Background

DES (dual energy subtraction) method

High ergy

AI

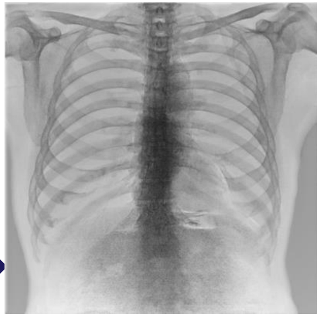
(kV)



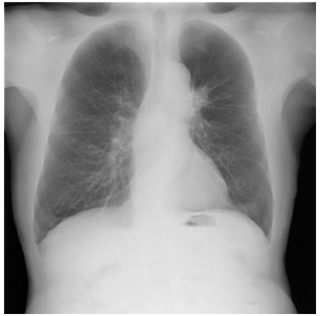
Low Energy
(60kV)

Sunbtraction

Bone image



Soft-tissue image



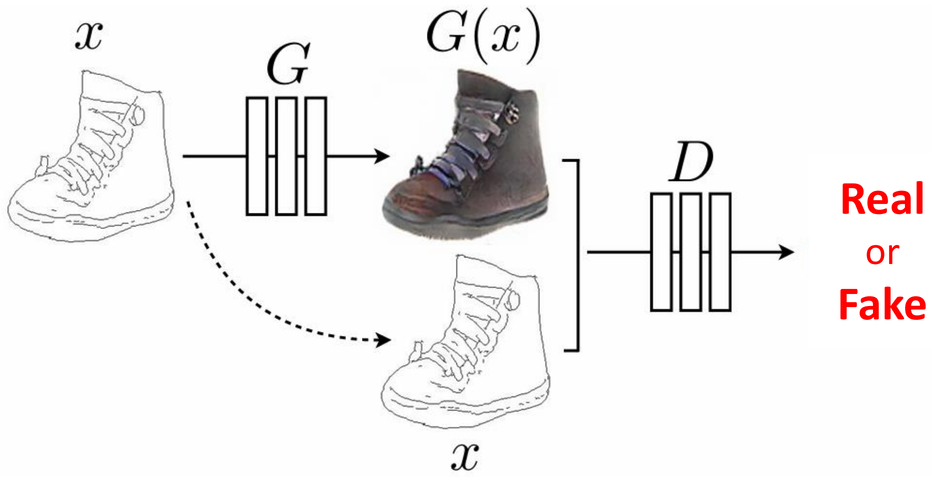
Problems

- Single-shot : Detect plate
  ⇒ *li increased noise*
- Dual- required
  eased exposure, artifacts

Solved by AI-DES

Pix2pix [1]

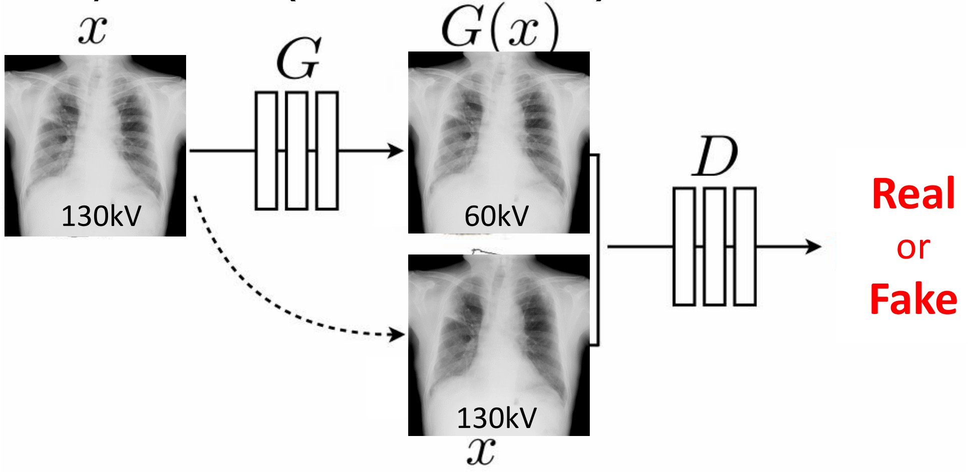
- Deep learning model used for image style conversion
  A type of Conditional GAN (Generative Adversarial Networks)



[1] P. Isora, J.-Y. Zhu, T. Shou, and A.A. Efros. ”Image-to Image Translation with Conditional Adversarial Networks,” *Proceedings of 2017 IEEE **CVPR***, 2017

Creating an AI network

- High energy image ⇒ Generation of pseudo low energy image
  (130kV) (60kV)
- Training using 240 chest X-ray images from Kitasato University Hospital obtained by Dual-shot method
  Discovery XR656 (GE Healthcare)



[1] P. Isora, J.-Y. Zhu, T. Shou, and A.A. Efros. ”Image-to Image Translation with Conditional Adversarial Networks,” *Proceedings of 2017 IEEE **CVPR***, 2017

Creating an AI network

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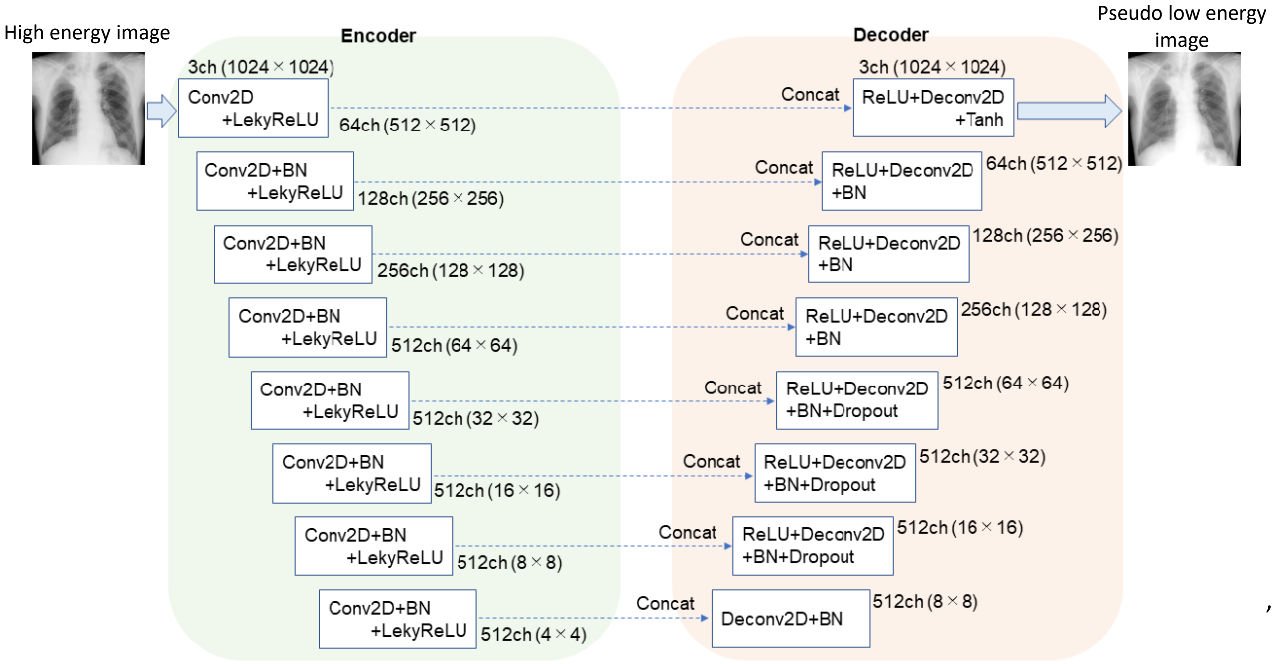
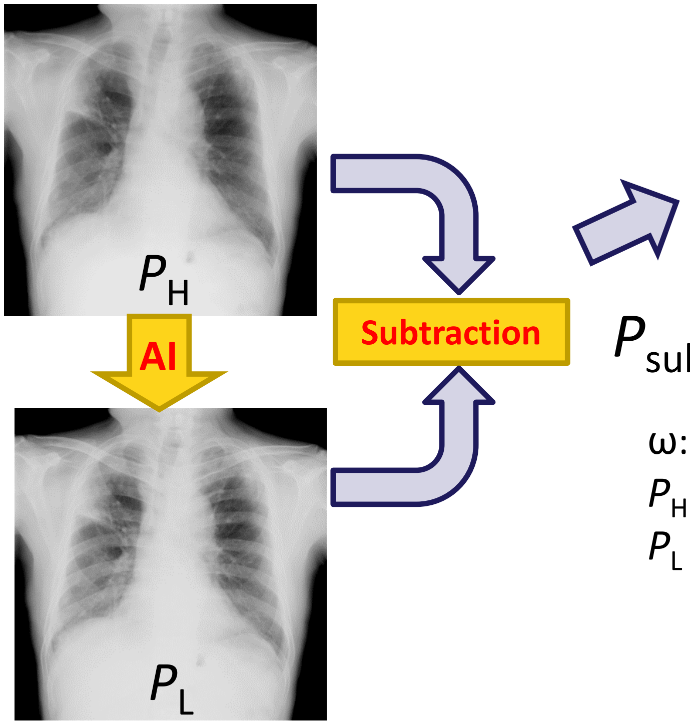


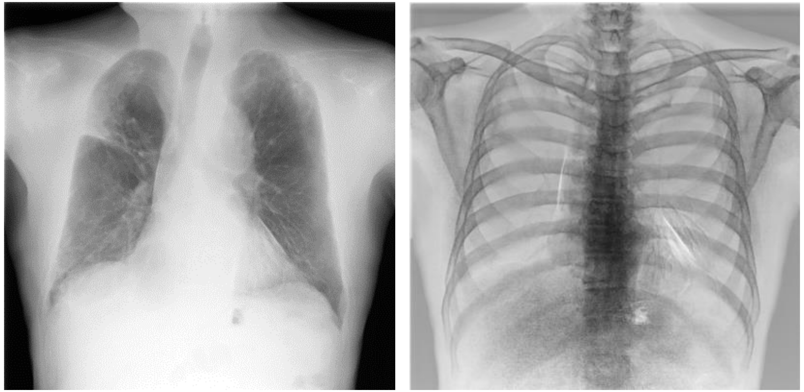
,

AI-DES

High energy image



pseudo low energy image



$$P_{sub} = \omega \cdot \log(P_H) - \log(P_L)$$

ω: Weight

P_H: Pixel value of high energy image

P_L : Pixel value of pseudo low energy image

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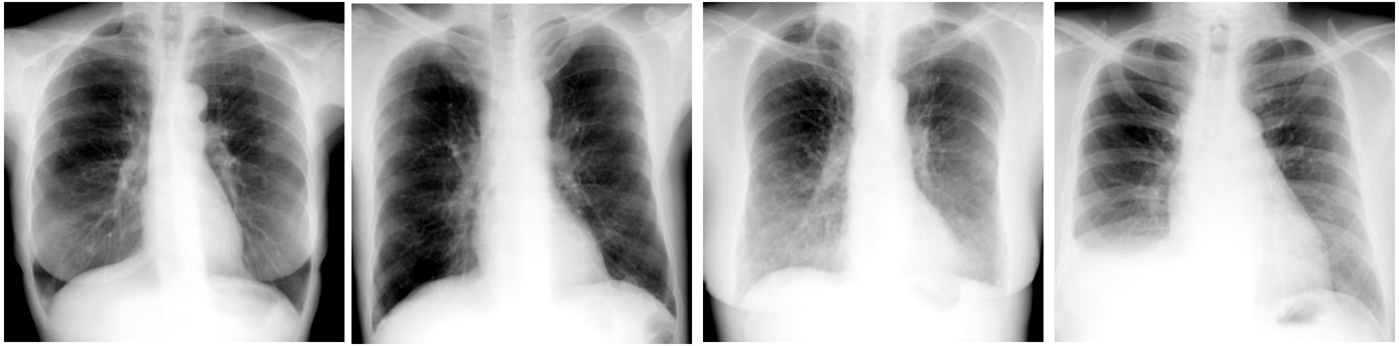
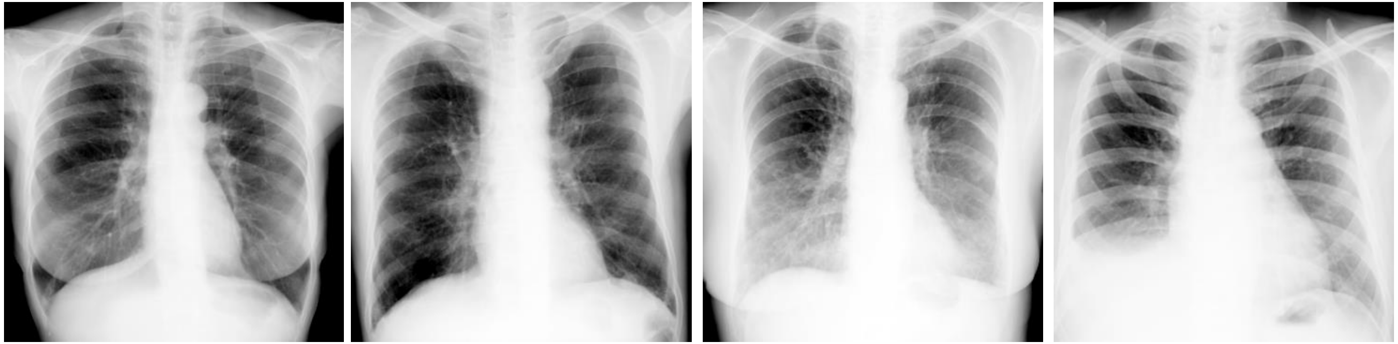
Pseudo low energy image generated by AI

High Energy Chest Radiograph (130kV)



AI

Pseudo Low Energy Chest Radiograph



Pseudo low energy image generated by AI

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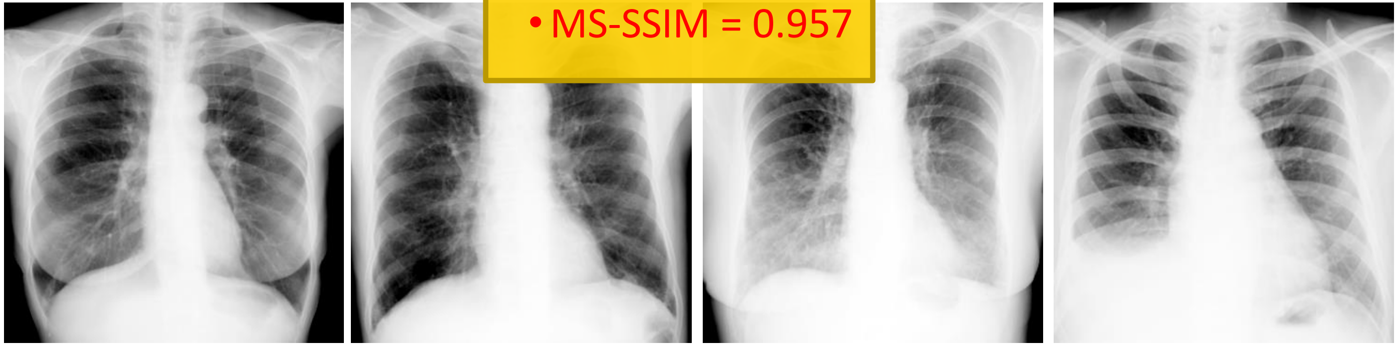
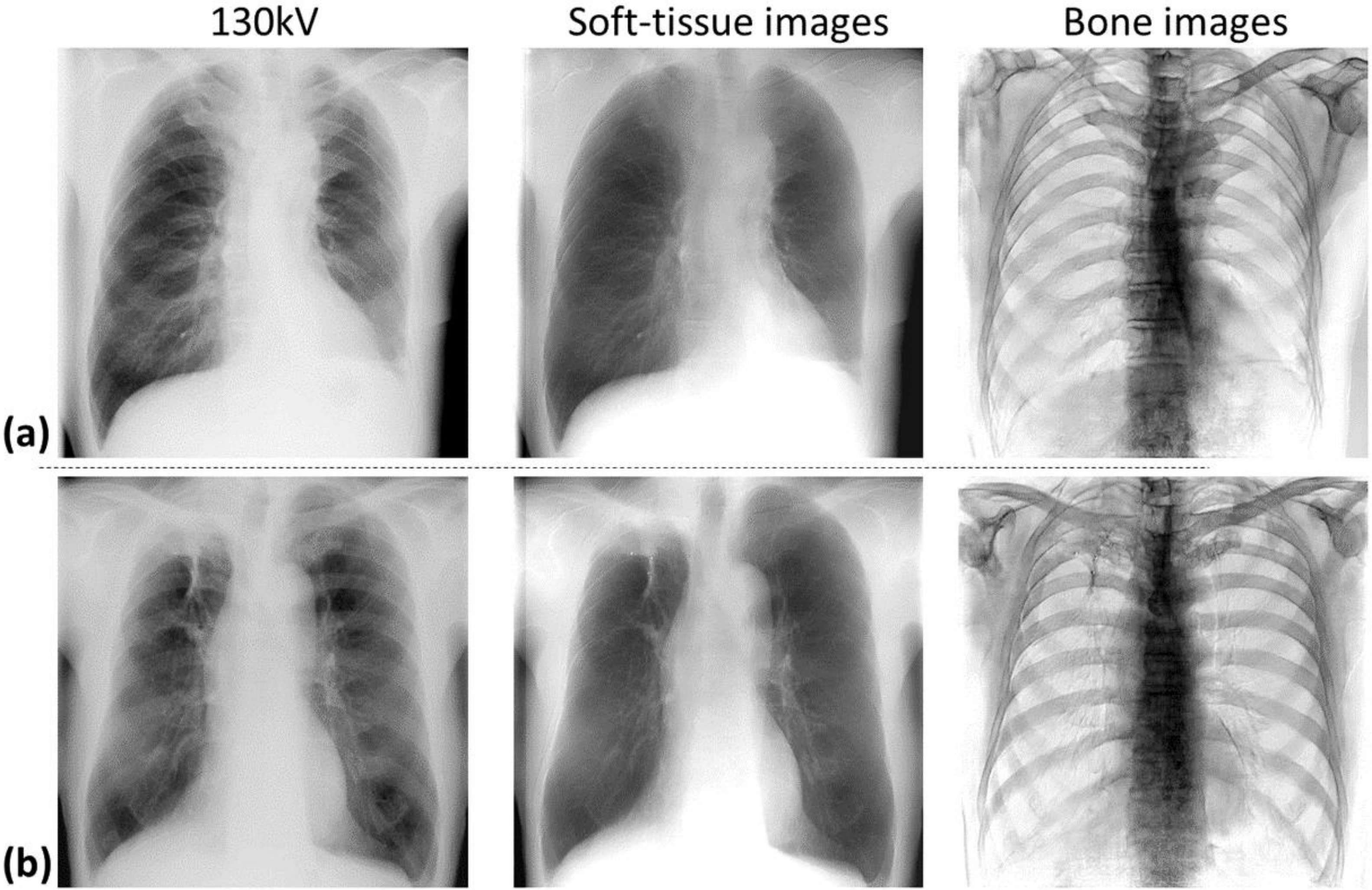
Real Low Energy Chest Radiograph (60kV)

Similarity

- PSNR = 33.8 dB
- SSIM = 0.984
- MS-SSIM = 0.957

Pseudo Low Energy Chest Radiograph




130kV
Soft-tissue images
Bone images
(a)
(b)

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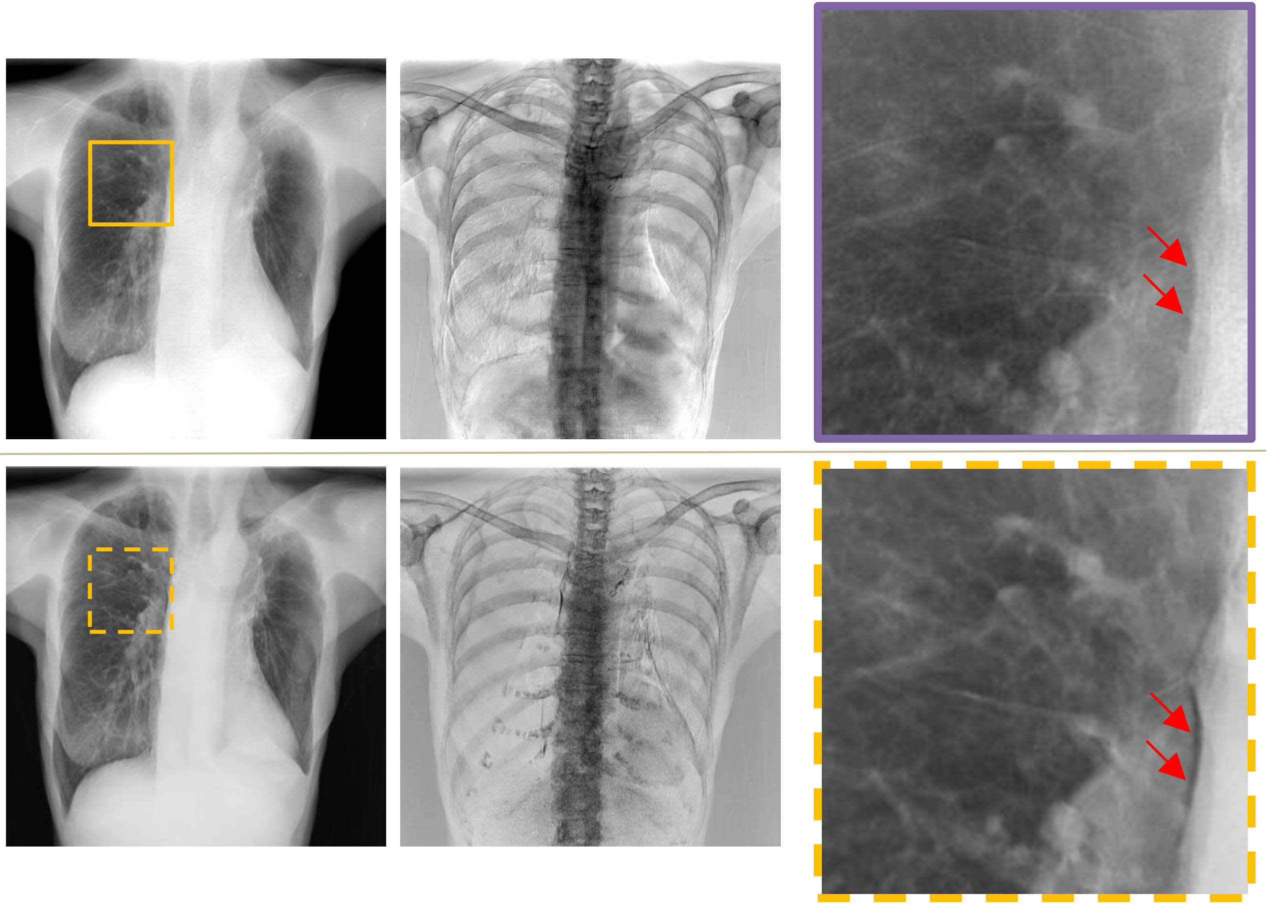
AI-DES vs Real DES

AI-DES

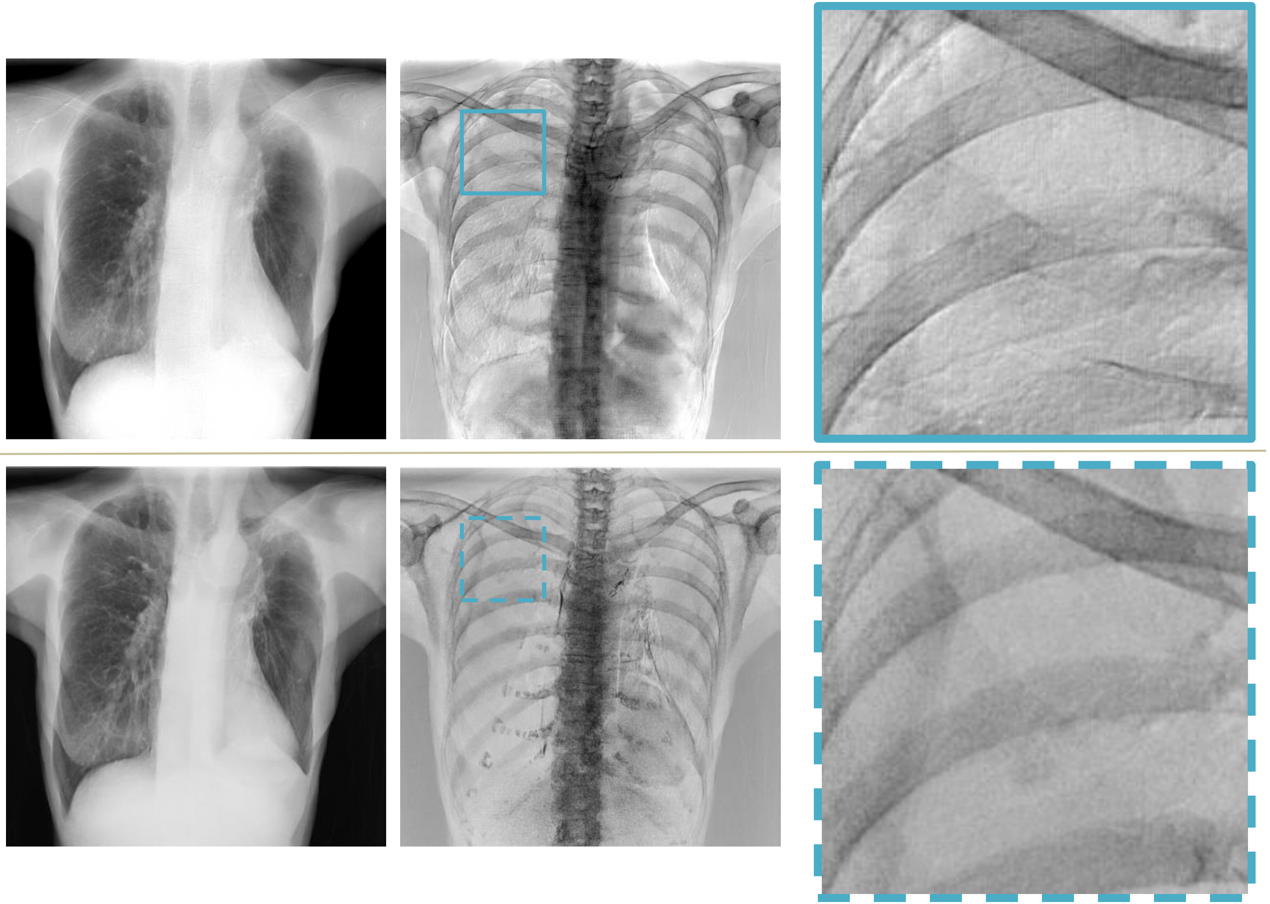
Discovery XR656 (GE)



AI-DES vs Real DES

AI-DES

Discovery XR656 (GE)



Summary

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- We have developed AI-DES that generates soft tissue and bone images from a high-energy chest X-ray image.
- Image quality of the generated image is comparable to clinically used systems.
- Solved the problems of existing DES methods (limited facilities, increased radiation exposure, noise degradation, motion artifacts)

  ⇒Image diagnosis with a large amount of information through routine examinations
- Future challenges include countermeasures against artifacts in bone images and verification of clinical usefulness.

applied sciences

Two-View Mammogram Synthesis from Single-View Data Using Generative Adversarial Networks

by Asumi Yamazaki and Takayuki Ishida *

Division of Health Sciences, Osaka University Graduate School of Medicine, Suita 565-0871, Japan

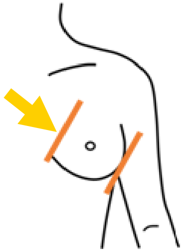
* Author to whom correspondence should be addressed.

Appl. Sci. **2022**, *12*(23), 12206; https://doi.org/10.3390/app122312206

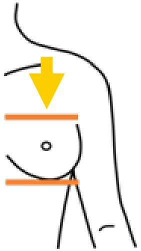
Submission received: 3 November 2022 / Revised: 25 November 2022 / Accepted: 26 November 2022 / Published: 29 November 2022

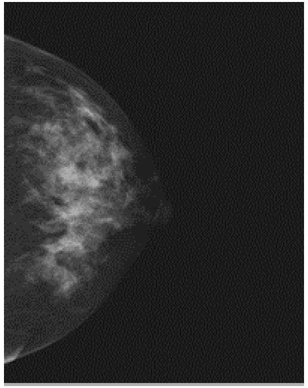
Another-view mammogram synthesis from single-view data

Mediolateral-oblique **(MLO)** view



Cranio-caudual**(CC)** view





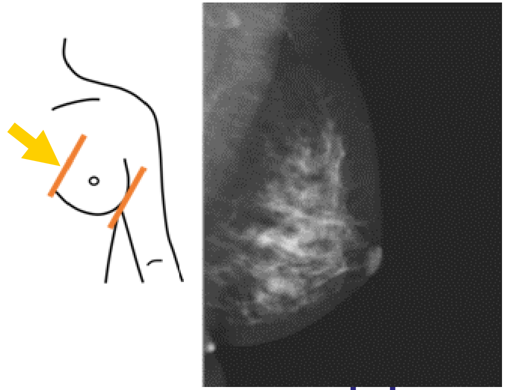
In Japanese breast cancer screening

- 35-40 yrs. : MLO + CC
- **Over 50 yrs**. : MLO only (single-view mammography)

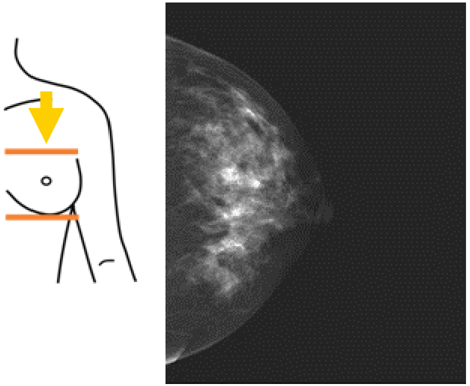
⇦ Lower cancer detection rate

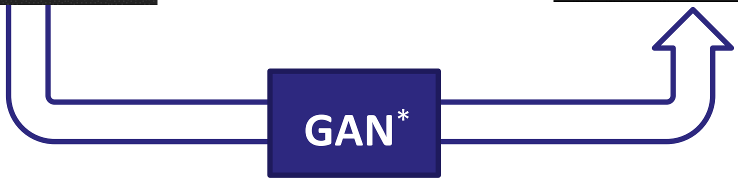
Another-view mammogram synthesis from single-view data

Mediolateral-oblique **(MLO)** view



Cranio-caudual **(CC)** view



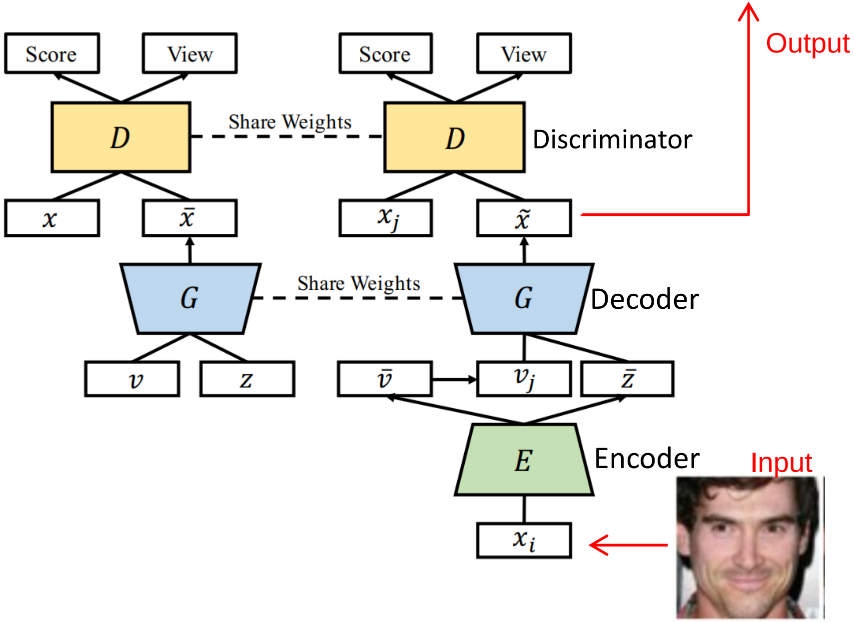


Expect an **increase in the cancer detection** rate with single-view mammography

*Generative adversarial networks **(GAN)**

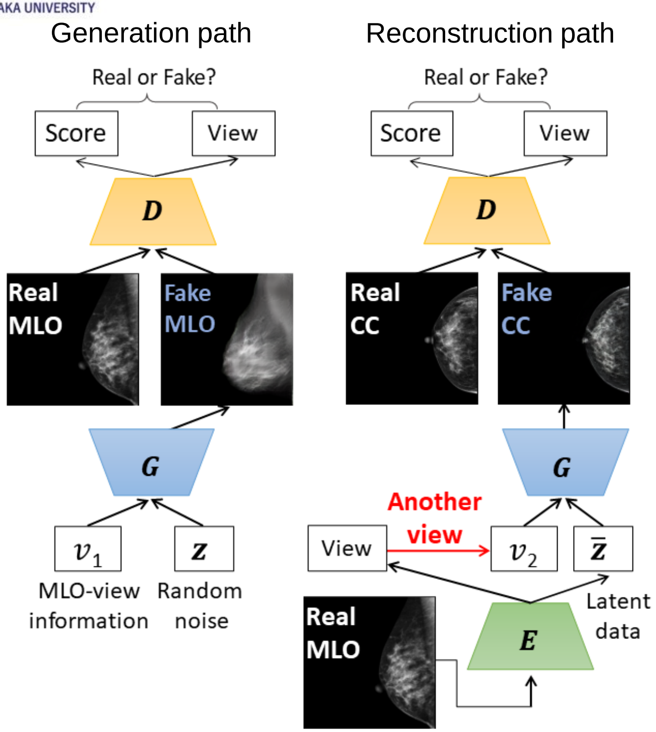
CR-GAN: Learning Complete Representations for Multi-view Generation

Yu Tian[1], Xi Peng[1], Long Zhao[1], Shaoting Zhang[2] and Dimitris N. Metaxas[1]
[1] Rutgers University
[2] University of North Carolina at Charlotte



The code is publicly available: https://github.com/bluer555/CR-GAN

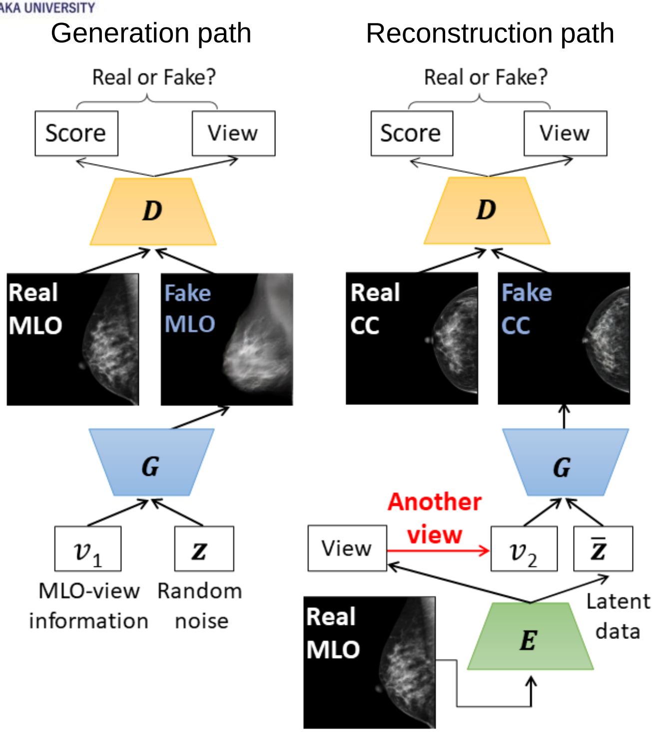
Another-view mammogram synthesis from single-view data

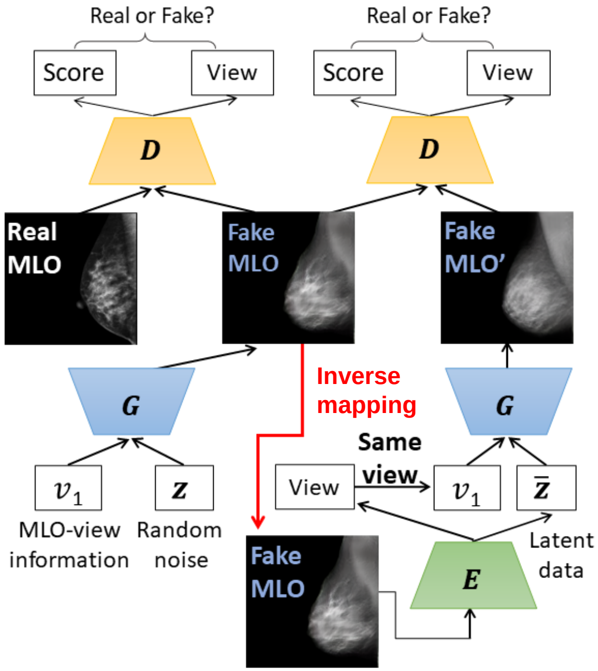


Two-pathway network

- Generation path:
  - *G* : random noise + view information →fake MLO or CC
  - *D* : discriminates real and fake views
- Reconstruction path:
  - *G* : real MLO→fake CC
  - *D* : discriminates real and fake views

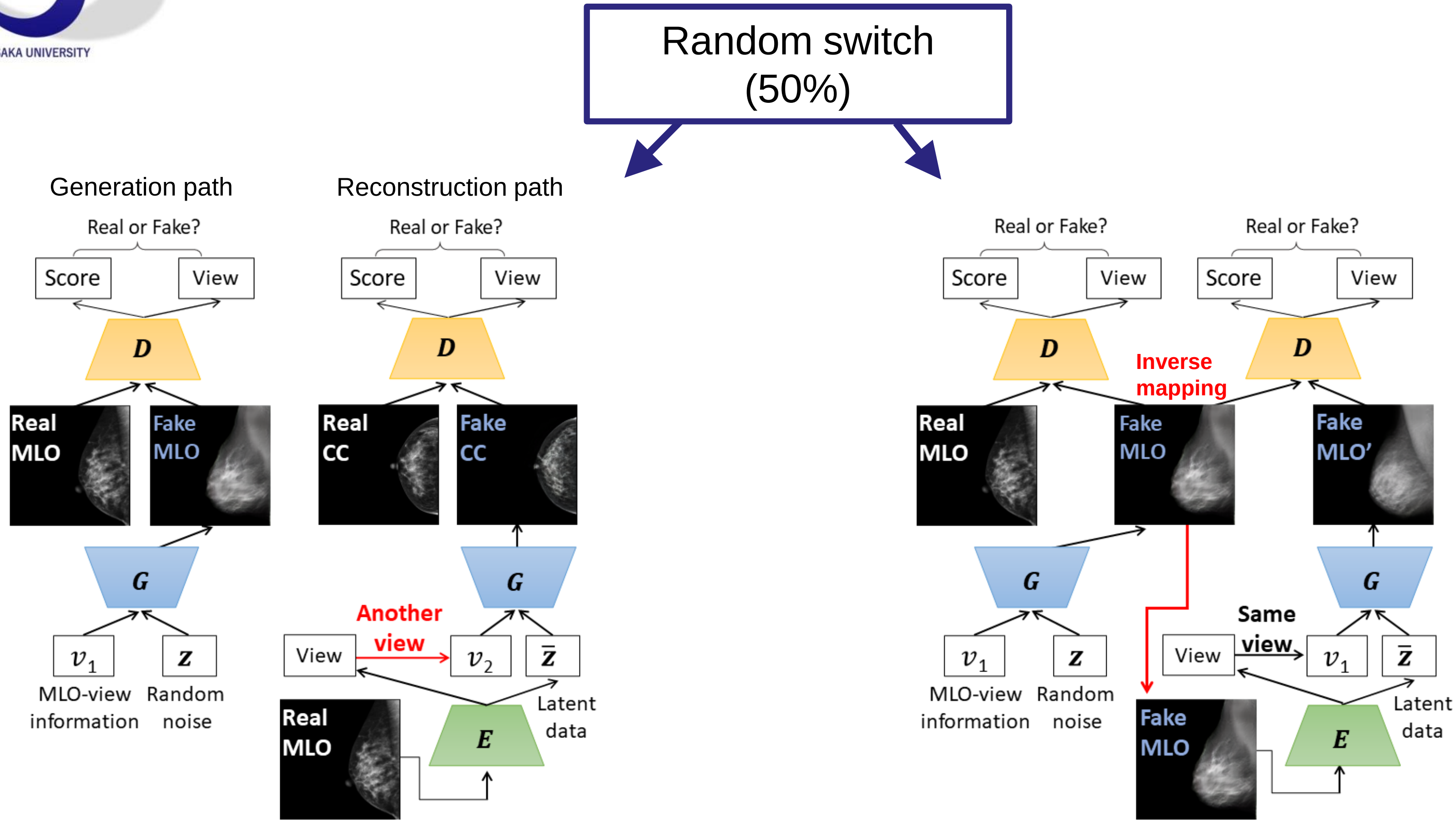
Another-view mammogram synthesis from single-view data





Generalization performance ↗

Another-view mammogram synthesis from single-view data



WGAN-GP (Wasserstein GAN-gradient penalty)

- The improved network of WGAN (Wasserstein GAN)
  – Optimization by Wasserstein distance
    - ***D*** maximizes
    - ***G*** minimizes

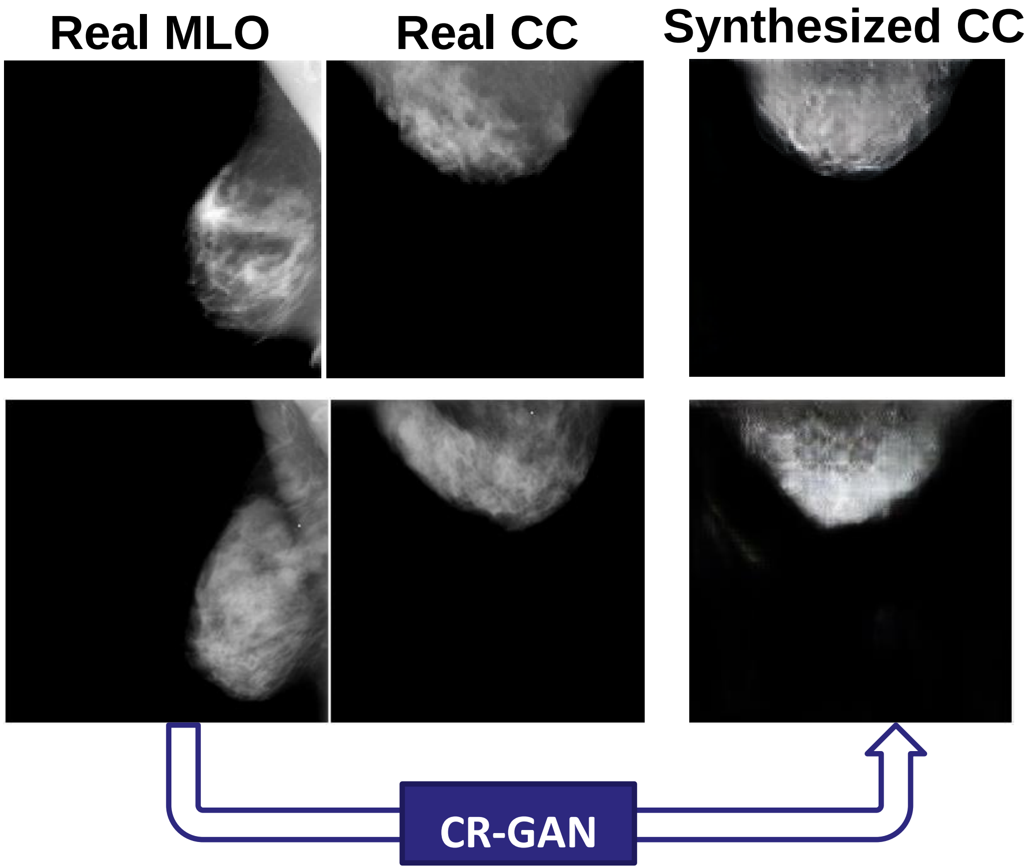
real, fake

$$W(\mathbb{P}_r, \mathbb{P}_\theta) = \mathop{\mathbb{E}}_{x \sim \mathbb{P}_r}[D(\boldsymbol{x})] - \mathop{\mathbb{E}}_{z \sim \mathbb{P}_\theta}[D(\bar{\boldsymbol{x}})],$$

- Stable and less prone to vanishing gradient problem

Arjovsky M. et al. "Wasserstein GANs," *arXiv.* 1701.07875, 2017

Synthesized image examples by CR-GAN



Modifications to CR-GAN

- PG (progressive growing) technique
- Feature matching loss

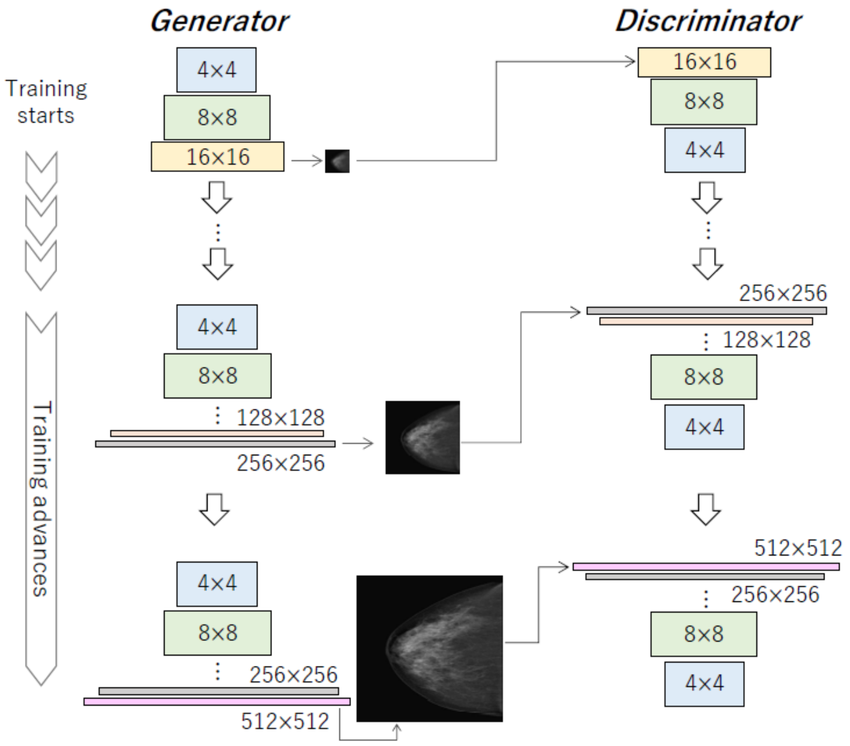
PG (progressive growing) technique

PG-GAN: Karras T. et al. "Progressive growing of GANs for improved quality, stability, and variation." *Proceedings of 6th ICLR*. 2018

- Increases image resolution as training advances.
- Learns higher-frequency image features gradually.

⇩

- Ensures stable training
- Results in reduced training time



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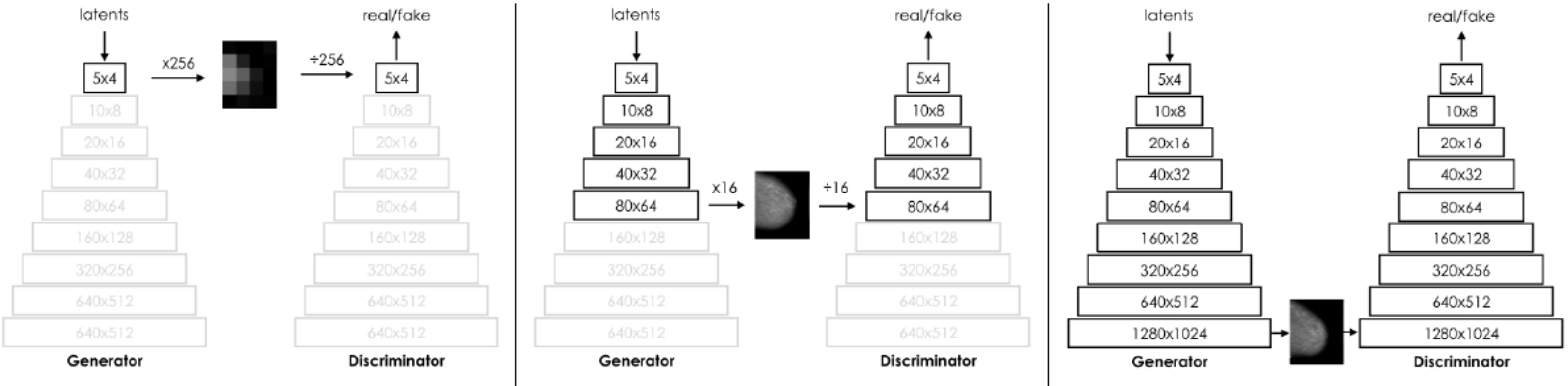
PG (progressive growing) technique

High-Resolution Mammogram Synthesis using Progressive Generative Adversarial Networks

Dimitrios Korkinof*†, Tobias Rijken†, Michael O'Neill†, Joseph Yearsley†, Hugh Harvey†, and Ben Glocker†,§

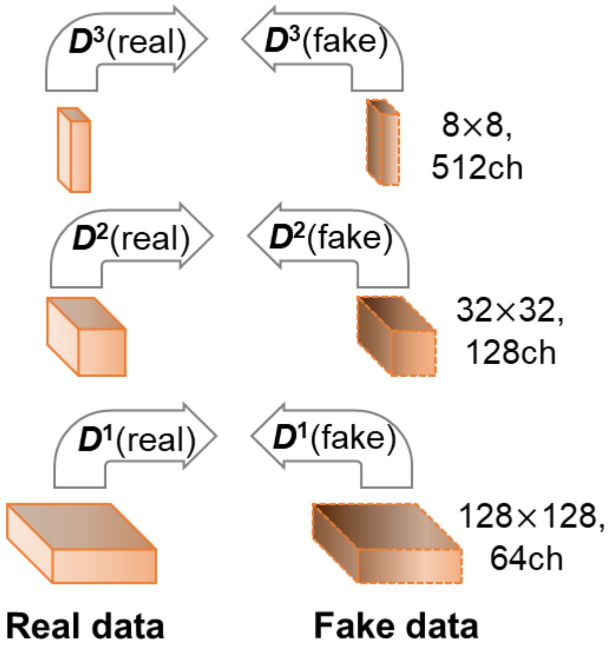
†Kheiron Medical Technologies Ltd.
§Department of Computing, Imperial College London



(a) Scale 0 (b) Scale 4 (c) Scale 8

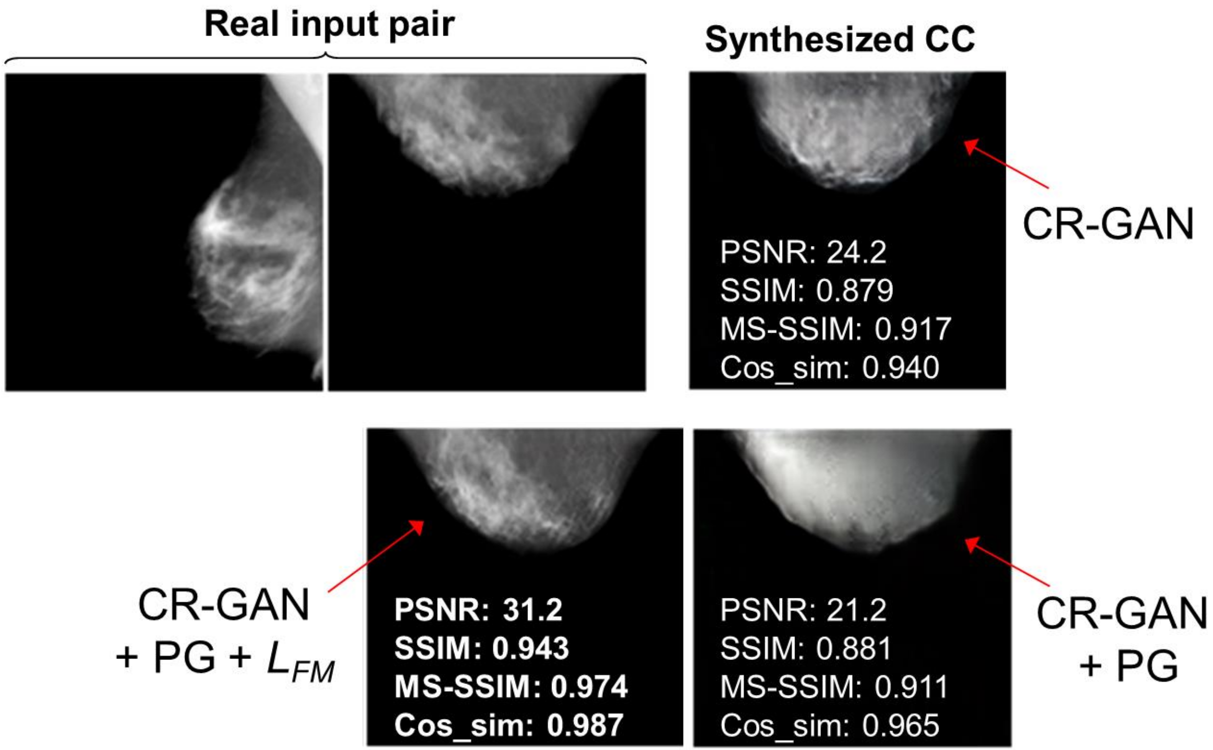
Feature matching loss (L_{FM})

Pix2pix HD: Wang T. et al. "High-resolution image synthesis and semantic manipulation with conditional GANs." *arXiv*. 1711.11585, 2017

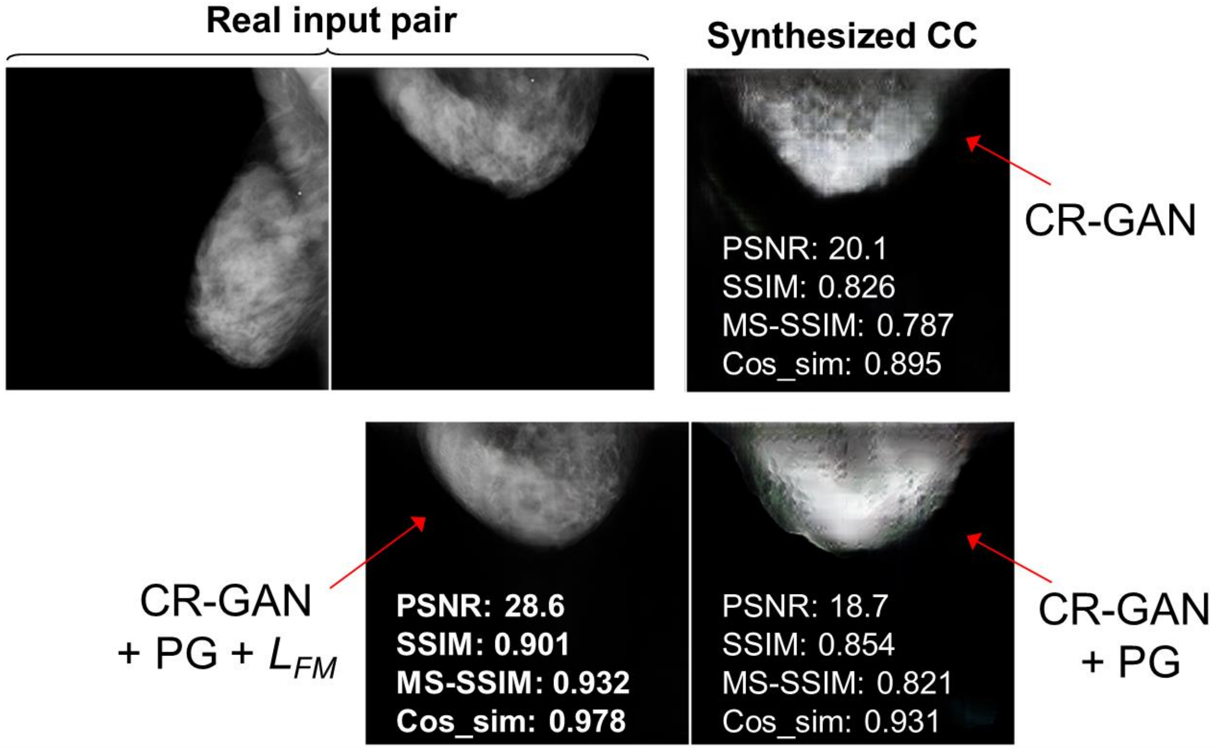


- Minimizes L1 distance between real and fake features
- Accomplishes sharper, more realistic image generation

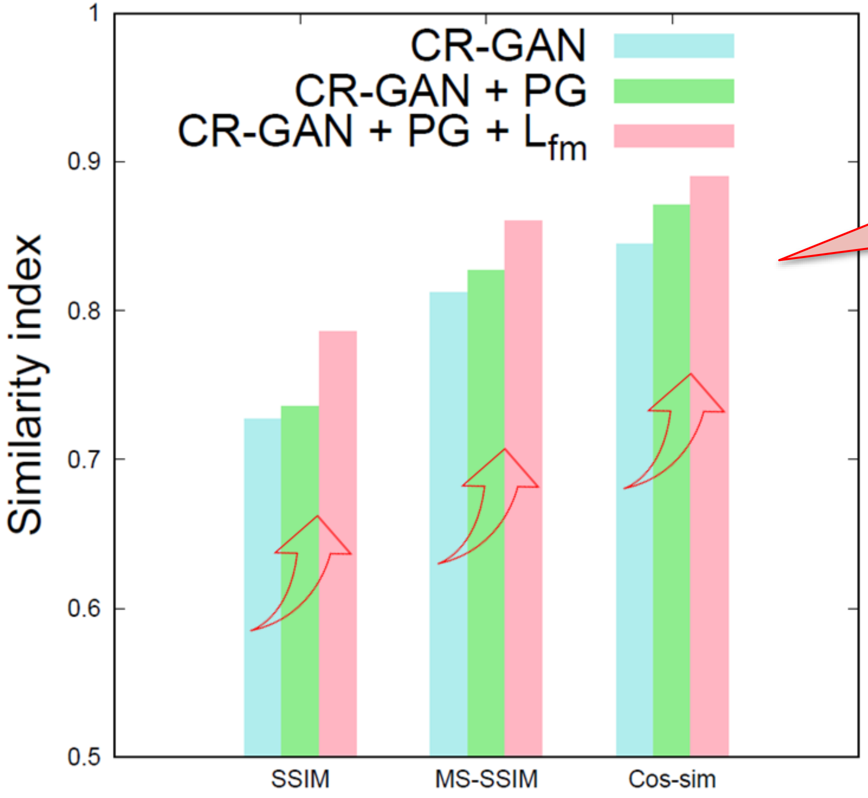
Comparison of synthesized images



Comparison of synthesized images



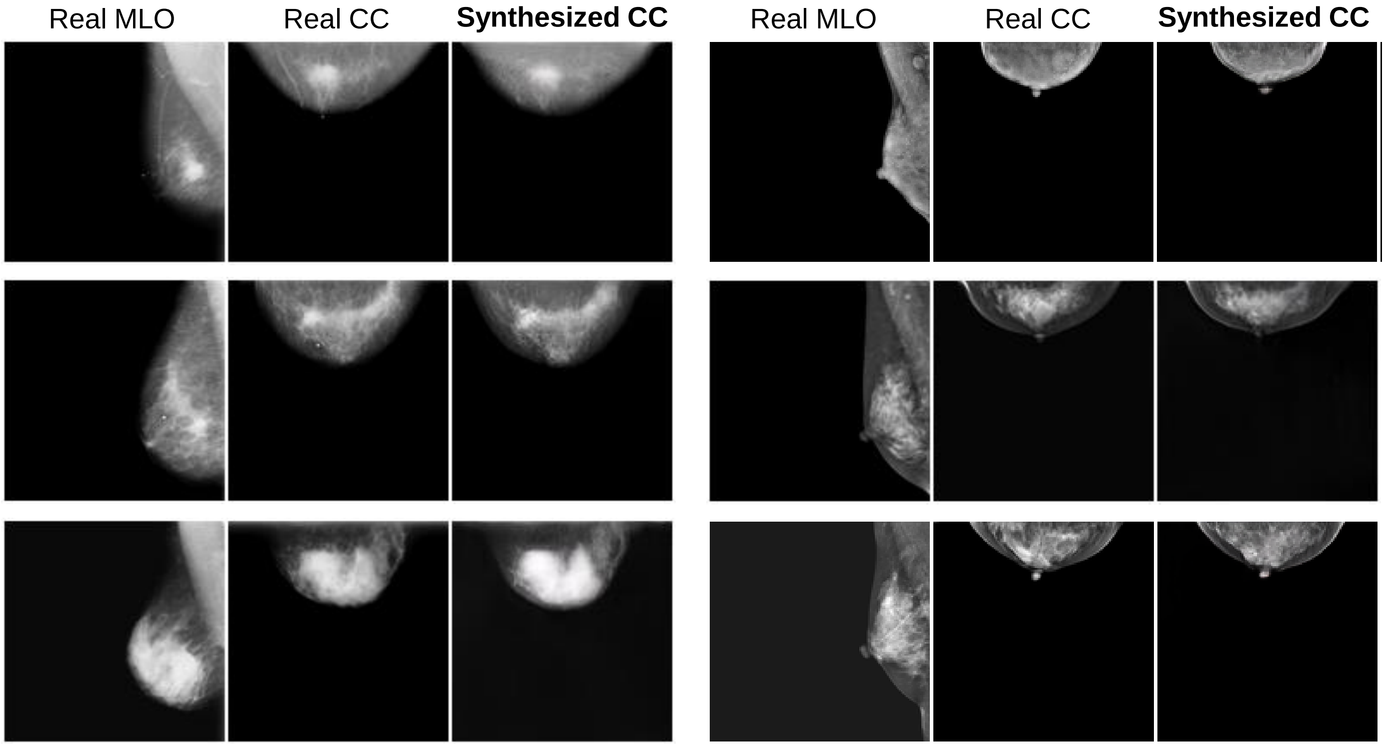
Similarity of real and synthesized CC views



Feature matching loss increased the image similarity.

- SSIM: structural similarity
- MS-SSIM: multi-scale structural similarity
- Cos-sim: cosine similarity

Successful cases of synthesized images



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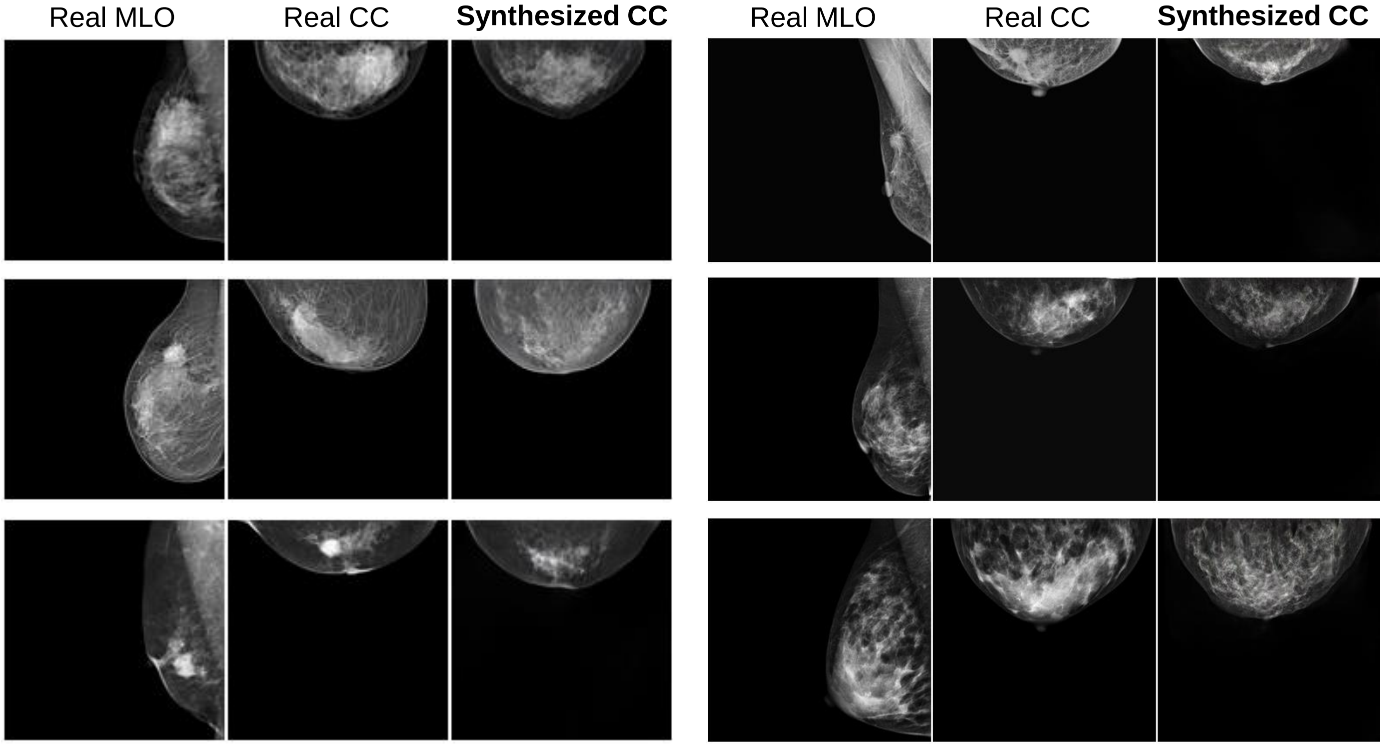
Failed cases of synthesized images



Thank you for your attention.