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Artificial Intelligence Role in Biomedical Engineering: Today and Tomorrow

Prof. Hossam El-Din Moustafa

Within the 21st International Operations & Maintenance Conference in the Arab Countries

An Initiative by
OMAINTEC
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Collaborators
الجمعية العلمية السعودية للهندسة الطبية
Biomedical Engineering EGYPT

Biography

- Ph.D. in Electrical Communications Engineering, Mansoura University,

Ph.D. Title: “Biomedical Applications of Image Registration and Fusion”.

- M.Sc. in Electrical Communications Engineering, Mansoura University,

M.Sc. Title: “Analysis and Classification of Esophageal Motility Records”.

- B.Sc. in Electronics Engineering, 1993, Mansoura University, Egypt.
- Scopus Profile

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- Publons Profile

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- Research gate Profile

https://www.researchgate.net/profile/Hossam-El-Din-Moustafa

- Google Scholar Profile

https://scholar.google.com/citations?hl=en&user=b9qdYLEAAAAJ

Biography

General Experience and Management Positions

- General Coordinator of Specific Programs Faculty of Engineering - Mansoura University from 2021 till now
- Founder and executive manager of the Biomedical Engineering Program - Faculty of Engineering - Mansoura University from 2017 to 2021.
- A certified auditor with the National Authority for Educational Quality Assurance and Accreditation
- Member of the list of arbitrators of the permanent scientific committee for electronics, communications and biomedical engineering - the 14th session
- Member of the executive office of quality assurance unit – Faculty of Engineering – Mansoura University, 2021.
- Member of the Committee for Specifying and Supplying Brain Catheterization Device for Mansoura University Hospital.
- Vice manager of the Biomedical Engineering Program - Faculty of Engineering - Mansoura University from 2014 to 2017.

Biography

Seminars and Conferences

- Member of the steering committee of the 2nd International Telecommunications Conference – Air Defense College – 2022
- Member of the organization committee of the 38th National Conference on Radio Science - Faculty of Engineering - Mansoura University - 2021
- Member of the reviewer committee of the 2nd International Telecommunications Conference – Air Defense College –2022
- Member of the Scientific Committee of the International Conference Japan - Africa, for Electronics, Communications - Egyptian Japanese University – 2021
- The 37th National Conference on Radio Science - German University in Cairo - 2020
- The first engineering forum - Faculty of Engineering - Mansoura University - 2020
- Higher Education Internationalization Conference - Mansoura University - 2019

Contribution in The Field

1. *N. El-Menbawy, M. El-Seddek, A. El-Nakib, H. Moustafa*, “Deep Segmentation of the Liver and the Hepatic Tumors from Abdomen CT Images”, International Journal of Electrical and Computer Engineering (IJECE), Vol.1, No. 12, 2022.
2. D. Arafa, H. Moustafa, A. Thabet, “Early Detection of Alzheimer’s Disease Based on The State-of-The-Art Deep Learning Approach: A Comprehensive Survey”, Multimedia Tools and Applications, Vol. 81, pp. 23735–23776, 2022.
3. A. Hekal, H. Moustafa, A. Elnakib, “Ensemble deep learning system for early breast cancer detection”, Evolutionary Intelligence, Vol. 16, pp. 1045–1054, 2023.
4. M. Ahmed, F. Khalifa, H. Moustafa, G. Saleh, E. Abdel Halim, “A Deep Learning Based System For Accurate Diagnosis of Brain Tumors Using T1-w MRI”, International Journal of Electrical and Computer Engineering, Vol. 28, No. 2, pp. 1192-1202, 2022.
5. M. El-Genidy, H. khater, H. Moustafa, E. Abd Elhalim, "An MRI-based deep learning approach for accurate detection of Alzheimer’s disease", Alexandria Engineering Journal, Volume 63, pp. 211-221, 2023.

Contribution in The Field

6. A. Haraz, A. Tawakol, H. Moustafa and A. Tanbouly, “Deep Learning-Based Technique for The Perception of The Cervical Cancer”, Mansoura Engineering Journal, Vol. 48, Issue 3, 2023.
7. M. El Sherbiny, E. Abdelhalim, H. Mostafa, M. El-Seddik, “Classification of Chronic Kidney Disease Based on Machine Learning Techniques”, Indonesian Journal of Electrical Engineering and Computer Science, Vol. 32, No. 2, pp. 945-955, 2023.
8. R. Hegazy, E. Abdel Halim, H. Moustafa, “A Proposed Technique for Breast Cancer Prediction and Classification Based on Machine Learning”, European Chemical Bulletin, Vol. 12, issue 8, pp. 7648-7656, 2023.
9. S. Zaky, H. Moustafa, A. Tawakol. M. Moawad, “A Proposed Deep Learning Framework for ASD Diagnosis Using MRI Images”, European Chemical Bulletin, Vol. 12, issue 12, pp. 3756–3765, 2023.
10. S. Akram, W. Abo Samra, H. Moustafa, A. Tanbouly, “An Accurate Deep Learning System for the Detection of Glaucoma Using Fundus Images”, European Chemical Bulletin, Vol. 12, issue 12, pp. 1762-1775, 2023.

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Contribution in The Field

18. S. Fawzy, H. Moustafa, E. Abdel Hay, M. Ata, “A deep convolutional structure-based approach for accurate recognition of skin lesions in dermoscopy images”, International Journal of Electrical and Computer Engineering, Vol. 13, No. 5, pp. 5792-5803, 2023.

19. B. Elsayed, A. Alksas, M. Shehata, M. Abdelkhalek, M. Ghazal, S. Contractor, H. Moustafa, A. El-Baz, “Exploring Neoadjuvant Chemotherapy, Predictive Models, Radiomic, and Pathological Markers in Breast Cancer: A Comprehensive Review”, Cancers, Vol. 15, No. 21, 2023.

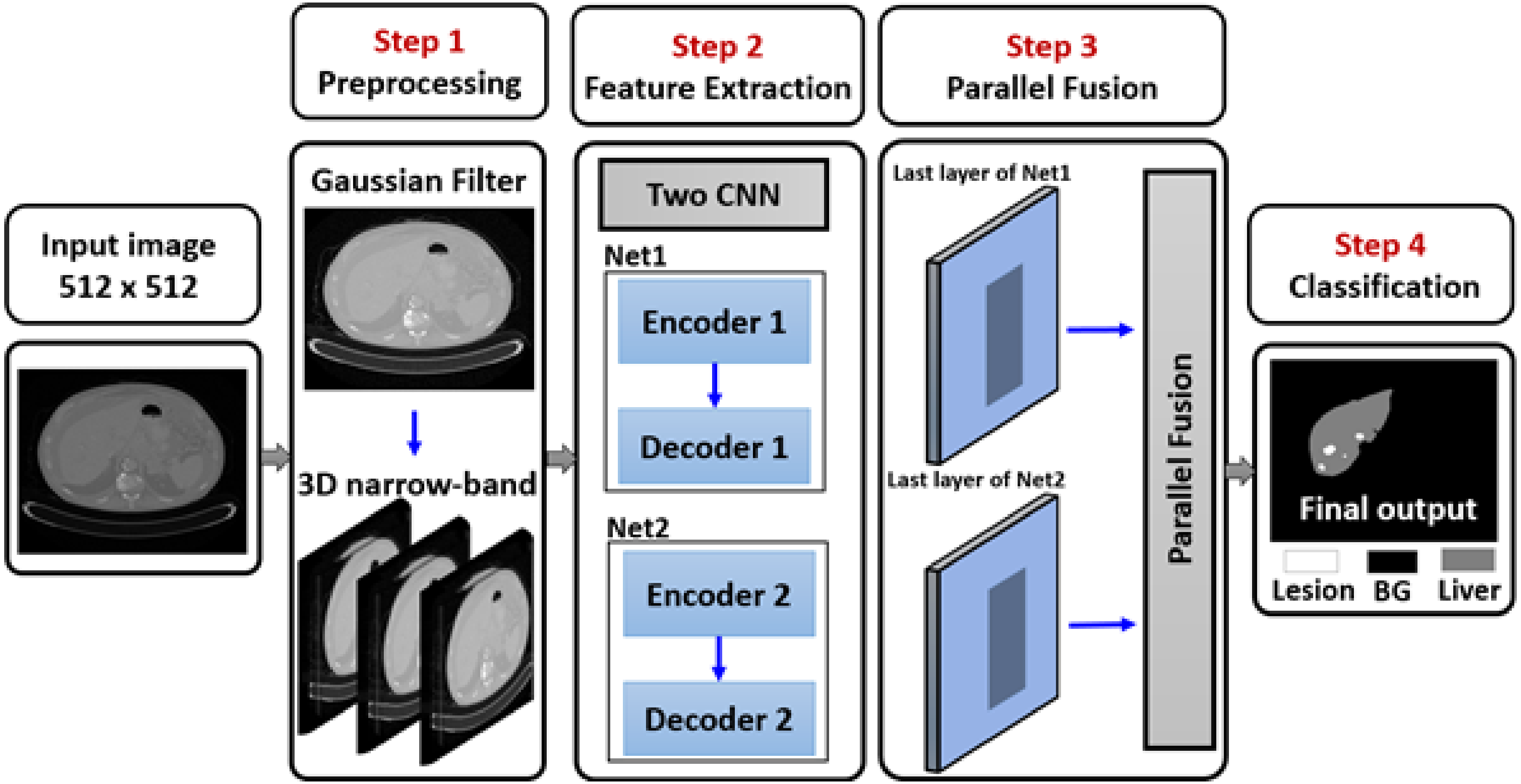
20. N. Yakout, E. Abdel Halim, A. Abdel Halim, H. Moustafa, “Classification of Kidney Masses Using Convolution Neural Network”, Mansoura Engineering Journal, Vol. 49, Issue 1, 2024.

21. S. Fawzy, H. Moustafa, E. Abdel Hay, M. Ata, “Proposed optimized active contour based approach for accurately skin lesion segmentation”, Multimedia Tools and Applications, Vol. 83, 2024.

22. A. Haikal, A. El-Nakib, H. Moustafa, H. Amer, “Breast Cancer Segmentation from Ultrasound Images Using Deep Dual-Decoder Technology with Attention Network”, IEEE access, 2024.

23. A. Hamed, H. Moustafa, M. Aouf, “Deep Learning Based Classification of Focal Liver Lesions with 3 and 4 Phase Contrast-Enhanced CT Protocols”, Mansoura Engineering Journal, 2024 (Accepted on Jan., 12, 2024).

Deep Multi-Stage System for Liver and Lesions Segmentation Using CT Images (19-10-2023)



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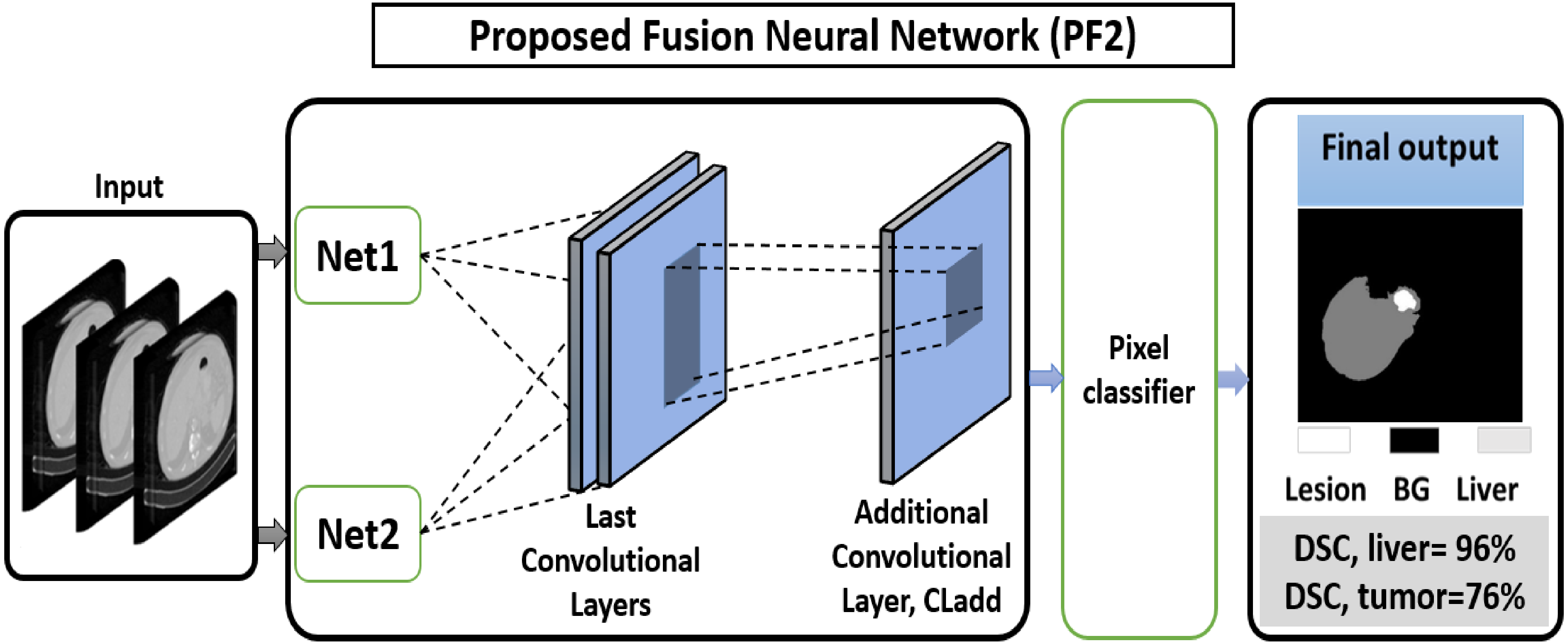
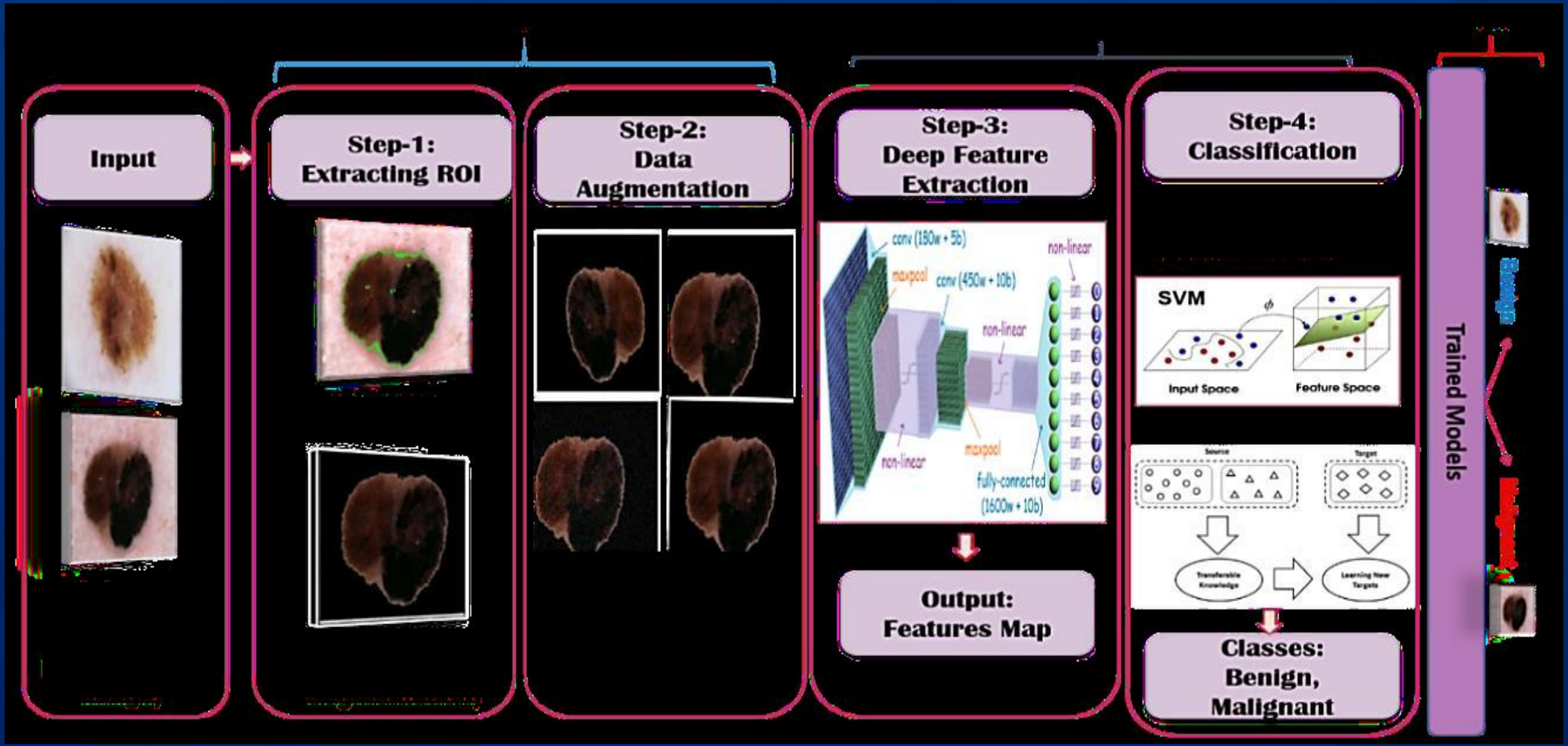


Deep Multi-Stage System for Liver and Lesions Segmentation Using CT Images (19-10-2023)

Model	Object	Liver			Tumor		
	Mode	Global	per case		Global	per case	
	Metric	DSC	DSC	ASSD	DSC	DSC	ASSD
Model 1 VGG16 Segnet	Duplicate	83.6%	77.5%	4.80	69.2%	63.21%	4.13
	3D Narrow-band	83.6%	77.5%	4.80	74.7%	67.3%	2.45
Model 2 FCN Alexnet	Duplicate	96.8%	92.01%	0.87	75.1%	68.4%	2.10
	3D Narrow-band	96.8%	92.01%	0.87	76.9%	72.5%	2.08
Parallel Fusing using FP1	Duplicate	97.2%	92.9%	0.82	78.2%	73.9%	1.29
	3D Narrow-band	97.2%	92.9%	0.82	79.8%	75.2%	0.68
Proposed System (FP2)	Duplicate	98.1%	95.3%	0.45	85.5%	76.2%	0.91
	3D Narrow-band	98.1%	95.3%	0.45	87.2%	78.1%	0.53

Automated Skin Cancer Detection and Classification System

- **Graphical Abstract:**



Automated Skin Cancer Detection and Classification System

References	Dataset	Method	Observations	Accuracy %
Li and Shen [30]	ISIC	Two deep learning method	lesion classification	91.2%
Hosny *et al.* [32]	ISIC2018	AlexNet, 10-fold cross-validation, fine-tune, transfer learning, Augmentation, GPU	lesion classification	92.99%
Hosny *et al.* [33]	ISIC2019	GoogleNet, Similarity score, bootstrap weighted SVM classifier, SoftMax, fine-tune, transfer learning, Augmentation.	lesion classification	98.70%
Khan *et al.* [34]	ISBI 2016 ISBI 2017 ISBI 2018 PH2	Novel Deep Saliency Segmentation method, ten-layer convolutional neural network (CNN), and Kernel Extreme Learning Machine (KELM) classifier.	lesion classification	95.38% 95.79% 92.69% 98.70%
Abayomi-Alli *et al.* [35]	PH2	Deep CNN-based using SqueezeNet and covariant SMOTE augmentation in low dimensional manifold.	lesion classification	92.18%
Kawahara *et al.* [43]	ISIC	Linear classifier CNN deep learning.	lesion classification	85.5%
Codella *et al.* [44]	ISIC	Deep learning, sparse coding, SVM.	lesion classification	93.1%
Proposed Method 1	ISIC	**CNNs based on GoogleNet.**	**lesion classification**	**99.8%**
		CNNs based on AlexNet.	lesion classification	98.8%
		CNNs based on ResNet-50.	**lesion classification**	**99.3%**
		CNNs based on VGG19.	lesion classification	98.8%
Proposed Method 2	CPTAC-CM	**CNNs based on GoogleNet.**	**lesion classification**	**99.87%**
		CNNs based on AlexNet.	**lesion classification**	**99.9%**
		CNNs based on ResNet-50.	lesion classification	99.6%
		CNNs based on VGG19.	lesion classification	99.6%

Recent Trends in Biomedical Engineering

- Biomedicine and bioengineering have often been at the cutting edge of health care.
- Major breakthroughs from the field — like X-rays, biosensors, In vitro fertilization (IVF) and cell therapies — sometimes change how doctors approach patient care in general.
- Several new trends are reshaping the bioengineering industry. They may have a significant impact on the direction healthcare research takes over the next few years.
- These are some of the most important new developments in bioengineering — and how care providers may use them in the near future.

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(1) Surgical Robotics

- A new wave of robotics innovations have a major impact across various industries.
- In bioengineering, AI-assisted surgical robots are providing valuable support to surgeons in the operating room.
- New models come with AI algorithms that can provide improved support to surgeons.
- For example, AI-powered smoothing algorithms reduce jitters or noise in the recording of a surgeon’s hand movement, allowing for extremely careful and precise translation of their trajectory.
- Robots can conduct surgery entirely on their own. The Smart Tissue Autonomous Robot (STAR) performed better than people without any human intervention.

(1) Surgical Robotics

(2) Tele-Surgery

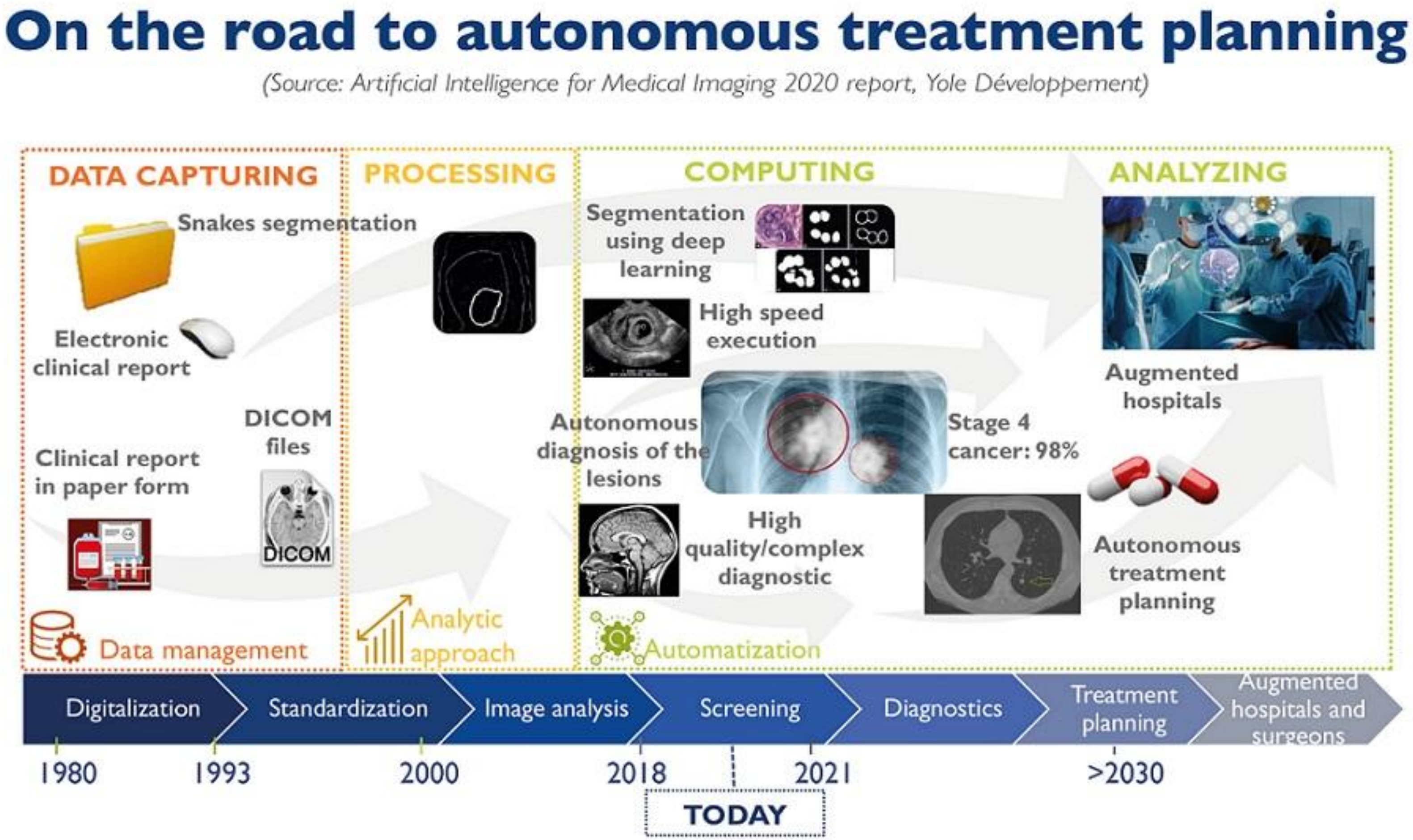
- Robotics could enable the use of tele-surgery or remote surgery.
- With tele-surgery, the surgeon controls a robot at another medical facility using a high-speed internet connection.
- The tele-surgery robot closely follows the hand movements or inputs of the doctor.
- New tele-surgery robots, enabled by improved internet infrastructure and technology like 5G and AI, could be different.
- Patients in need of surgery wouldn’t need to commute to a world-renowned hospital for treatments that are only available from a handful of doctors. Instead, they may be able to travel to a local hospital outfitted with the proper robotics.

(2) Tele-Surgery

(3) Artificial Intelligence in Medical Imaging

- AI technology was put into experimental practice during the COVID-19 pandemic when radiologists were required to analyze a huge number of chest X-rays/CT scans.
- Recent AI algorithms, trained on data from historical X-Ray/CT scans, were used in various hospitals and research environments as an assistive technology.
- They supported physicians by highlighting potential areas of interest in chest scans and suggesting diagnoses.
- According to meta-analysis published in Nature, these algorithms were, on average, highly accurate for 90.8% of the time.
- For example, one research team has used AI algorithms to optimize radiation doses, patient positioning and acquisition parameters in CT scans, decreasing the overall radiation necessary to create a clear result.

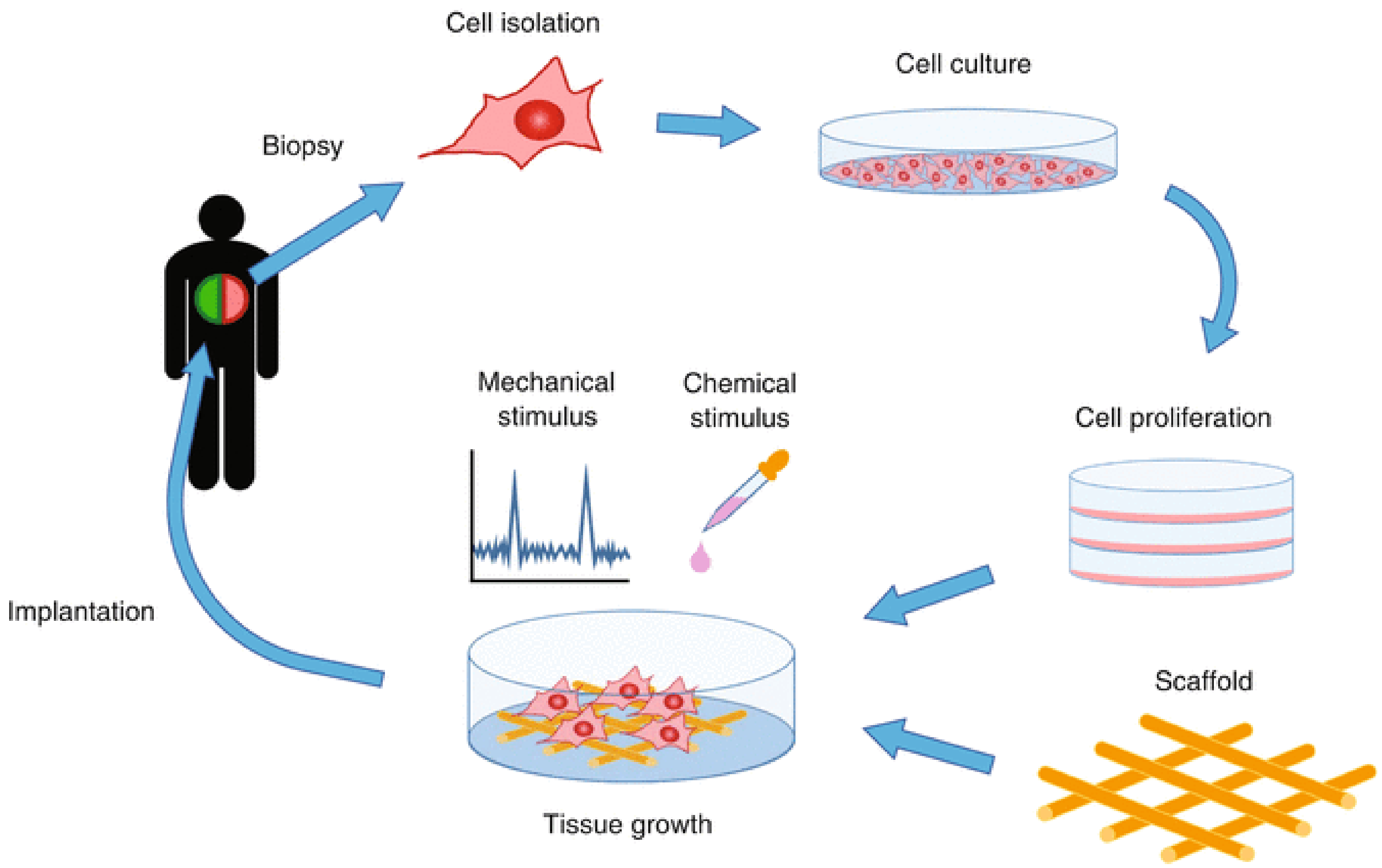
(3) Artificial Intelligence in Medical Imaging



(4) Bioprinting and Tissue Engineering

- Bioprinting or biofabrication technology is similar to 3D printing, the additive manufacturing method that creates objects from plastic filament. However, instead of plastic, bioprinting uses “bioinks” made up of active human cells, proteins, DNA and sometimes encased in stabilizing materials.
- A specialized bioprinter deposits these cells and particles precisely into thin layers, which can create tissues.
- With the help of support structures, these tissues can come together to form new, bioartificial organs.
- The technology could be used in the future to supply artificial organs to patients without the need for a donor.
- Bioprinting is a good alternative to autologous skin grafting, the process of transplanting healthy skin over burn wounds. The device deposits layers of skin tissue on wounds, helping to accelerate the healing process.

(4) Bioprinting and Tissue Engineering



(5) Medical Virtual Reality (VR)

- Virtual reality (VR) is a technology that uses visual displays and motion controllers to transport users to digital environments to medicine.
- Healthcare providers are experimenting with the use of VR in treating Alzheimer's patients.
- These patients often have limited mobility, which makes it hard for them to access new stimuli — usually provided in the form of day trips and time spent outdoors — which is positively correlated with an improvement in Alzheimer's symptoms.
- Medical VR programs can transport patients to a virtual environment, offering them new stimuli improving life quality.

(5) Medical Virtual Reality (VR)

Where Are We going? : Technological Trend

european respiratory society every breath counts

Technological Trend

1. Infant cry: Is it a noise or information?
2. Ear Lobe Crease: A Marker of Coronary Artery Disease?
3. Acoustic Analysis and Prediction of Type 2 Diabetes Using Voice Segments

(1) Infant Cry: Is It a Noise or Information?

- Egypt's Ministry of Health and Population announced that 2.36 million newborns underwent audiological examination as part of **President Abdel Fattah Al-Sisi**'s initiative for early detection and treatment of hearing loss since September 2019.
- Spokesperson for the Health Ministry stated that 133,901 children were transferred for re-examination through a confirmatory test.
- He explained that those children underwent further evaluation
- The proposed approach is to use infant cry signal.

(1) Infant Cry: Is It a Noise or Information?

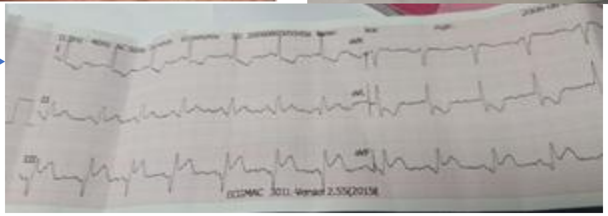
- Crying is a multimodal, dynamic behavior and the first way to communicate.
- Early identification of hearing impairment is critical for prevention of speech and language disorders.
- The present study aimed to assess the acoustic features of infant's cry signals to find possible differences between two groups including hearing impaired (HI) infants and normal hearing (NH).

NH

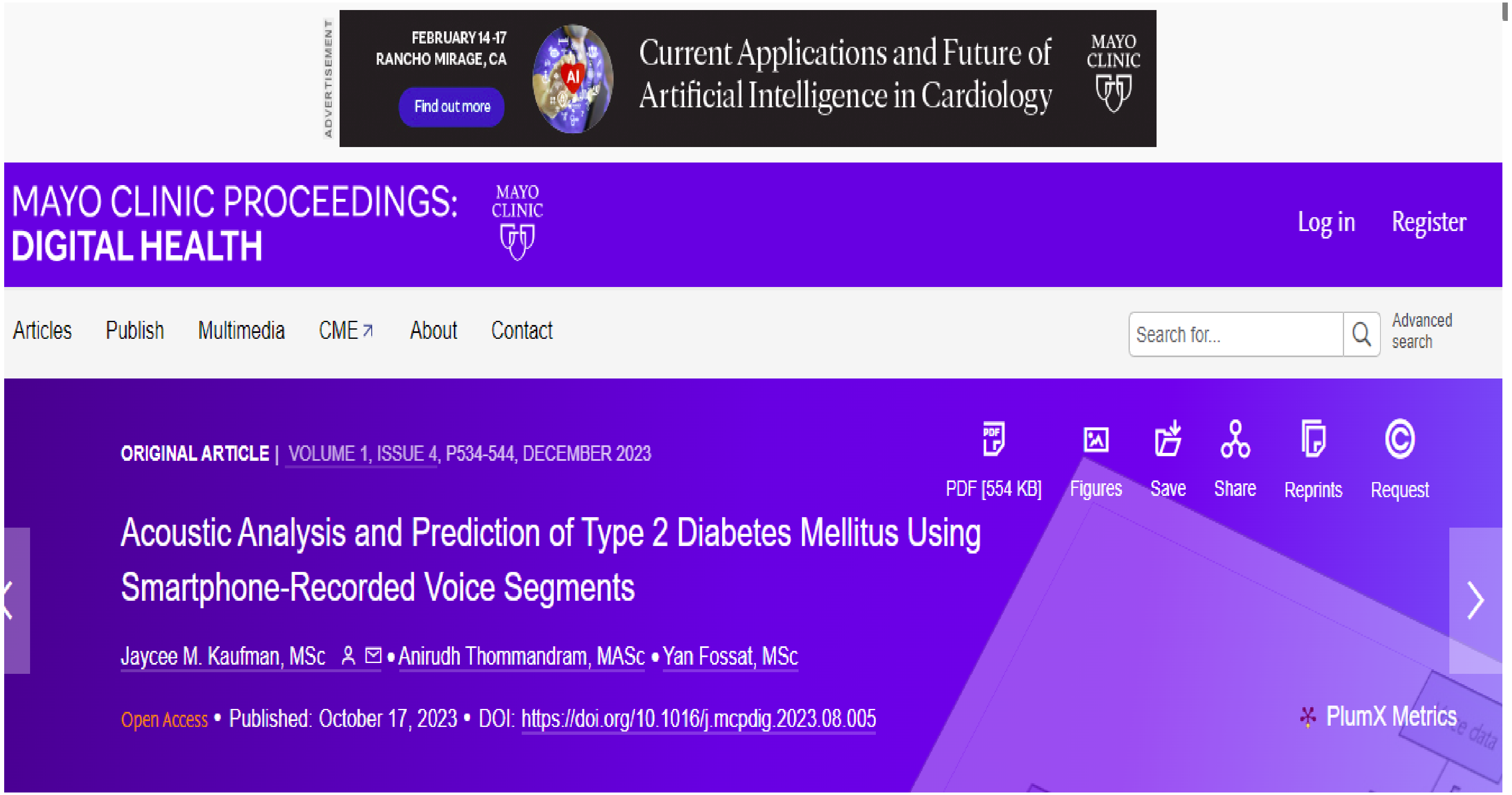
HI

(2) Ear Lobe Crease: A Marker of Coronary Artery Disease?

- Coronary artery disease (CAD) is a leading cause of death.
- There is a need for additional markers which might identify individuals at high risk of CAD.
- The ear lobe crease is a simple clinical sign that could be a potential predictor of CAD.
- جلطة بالجدار السفلى للقلب



Acoustic Analysis and Prediction of Type 2 Diabetes Using Voice Segments



The Dream

- The dream of having center of excellence in Biomedical Engineering

- Data collection
- Data processing
- Data standardization
- Connecting people (Engineers – Clinicians – Researchers – Patients) allover the world to serve community.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