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Republic of the Philippines
Southern Luzon State University
COLLEGE OF INDUSTRIAL TECHNOLOGY
Lucban, Quezon

June 1, 2023

Southern Luzon State University
Office of the President
Received
Date: 6/9/23
Time:
Received By: Diana Elizabeth Reyes P.

DORACIE B. ZOLETA-NANTES, Ph.D
University President
Southern Luzon State University
Lucban, Quezon

Thru: **MARISSA L. CADAO-ESPERAL, Ph.D**
Vice-President for REDPI
Southern Luzon State University
Lucban, Quezon

NICANOR L. GUINTO, Ph.D
Director, Office of Research Services
Southern Luzon State University
Lucban, Quezon

Dear Sir/Madam,

Good day! We humbly request for presentation financial assistance (PHP 14,128) if the funds still warrant for an accepted paper for this year's IEEE World Artificial Intelligence and Internet of Things Congress (AIIoT) to be held in Seattle, Washington, USA (sponsored by University of Washington) with provisions of virtual presentations on June 8 to 11, 2023 (Philippine Time).

The IEEE is arguably the most prestigious organization worldwide for Engineers and Technologists that aims to advance science further for the benefit of humanity.

We firmly believe that presentations (leading to publications) of our hard-earned work in knowledge generation can contribute to our future SUC leveling progress, the accreditation status of engineering programs, and other critical academic metrics of our University such as QS stars. Participation to world-class conference such as this has led to collaborative Q1 journal publications as a result of professional networking activity during the event.

Moreover, we will make sure that the absolute ownership of the research primarily belongs to Southern Luzon State University during the process of IEEE research licensing and publications.

Attached in this letter are all the documents pertaining to the conference and the papers.

We are humbly requesting this matter in the overall interest of our university and we are hoping for a positive response on this request.

Thank you very much.

Very truly yours,

REYNALDO V. DANGANAN, MIT
Assistant Professor II
Southern Luzon State University

Noted:

NICANOR L. GUINTO, Ph.D
Director, Research Services
Southern Luzon State University

Further approved by the president, please charge to OPS-CHA fund on Research Presentation Assistance. -NLG

approved

Doracie B. Zoleta-Nantes, PhD
University President

Recommending Approval:

MARISSA L. ESPERAL, Ph.D
VP-REPDI
Southern Luzon State University

JUN 08 2023

Republic of the Philippines
SOUTHERN LUZON STATE UNIVERSITY
Lucban, Quezon

Office of Research Services

AUTHORITY TO PARTICIPATE
IN A RESEARCH CONFERENCE

This is to certify that

Renato R. Maaliw III, Manuel P. Delos Santos, Maria Rossana D. de Veluz, Pitz Gerald G. Lagrazon, Mariebeth P. Seño, Devie R. Salvatierra – Bello, Reynaldo V. Danganan
(name/s of researcher/s)

is/are hereby **authorized** to attend/present the paper entitled

AWFCNET: An Attention-Aware Deep Learning Network with Fusion Classifier for Breast Cancer Classification Using Enhanced Mammograms
(Title of Paper)

in

IEEE 2023 World Artificial Intelligence and Internet of Things Congress (AIIoT), June 8 – 11, 2023 (Philippine Time) in Seattle, Washington, USA & Virtual
(Conference, Date, Venue)

on recommendation of the Office of Research Services and the Institutional Research Evaluation Committee.

Nicanor L. Guinto, Ph.D
Director, Office of Research Services
Co-Chair, IREC

Marissa G. Esperal, Ph.D
Vice President, Research, Extension, Production, Development & Innovation
Chair, IREC

Doracie B. Zoleta-Nantes, Ph.D
University President
Date:

CERTIFICATE OF PRESENTATION

THIS IS HEREBY PRESENTED TO

RENATO R. MAALIW III
(SOUTHERN LUZON STATE UNIVERSITY, PHILIPPINES)

FOR THE PAPER TITLED

AWFCNET: AN ATTENTION-AWARE DEEP LEARNING NETWORK WITH FUSION CLASSIFIER FOR BREAST CANCER CLASSIFICATION USING ENHANCED MAMMOGRAMS

IN THE SESSION

CAD DESIGN, COMPUTER VISION & NEURAL NETWORKS (SESSION 20)

AT IEEE AIIOT 2023
ON 7TH - 10TH JUNE 2023

SON VUONG
General co-chair, AIIOT 2023

SATYAJIT CHAKRABARTI
President, SMART Society

IEEE AIIoT 2023

2023 IEEE World AI IoT Congress (AIIoT)

Virtual Conference

7th – 10th June 2023

All the timings are given in Pacific Daylight Time (PDT (UTC−07))

TECHNICAL SCHEDULE

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	KEYNOTE 2 : SECURITY AND PRIVACY IN FEDERATED LEARNING	9:45 AM–10:30 AM	6
	-----BREAK-------	10:30 AM–10:45AM	6
	SESSION 1: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	10:45 AM–12:15 PM	8
	SESSION 2: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	10:45 AM–12:15 PM	9
	SESSION 3: SOFTWARE ENGINEERING; DATA MININIG,AUTOMATICCONTROL,NLP	10:45 AM–12:15 PM	10
	-----BREAK-------	12:15 PM-12:30 PM	10
	SESSION 4: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	12:30 PM–2:00 PM	11
	SESSION 5: PATTERN RECOGNITION;CLOUD COMPUTING;GRAPHICS	12:30 PM–2:00 PM	12
	SESSION 6: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	12:30 PM–2:00 PM	13

All the timings are given in Pacific Daylight Time (PDT (UTC−07))

DAY	EVENT DETAILS	TIMING	PAGE NUMBER
DAY 2 (8th JUNE 2023)	KEYNOTE 3: PHYSICS-INFORMED AI FOR ENABLING ROBOTS TO LEARN AUTONOMOUS TOOL MANIPULATION	8:30 AM–9:15 AM	14
	KEYNOTE 4: CUSTOMIZE AI MODEL IN BUSINESS: CASE STUDY IN KMTGVIETNAM (KHAI MINH TECHNOLOGY GROUP): KMTG'S BRAIN	9:15 AM–10:00 AM	14
	-----BREAK-------	10:00 AM–10:15 AM	14
	SESSION 7: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	10:15 AM–11:45 PM	16
	SESSION 8: BIG DATA;PARALLEL ALGORITHMS; SOFTWARE ENGINEERING	10:15 AM–11:45 PM	17
	SESSION 9: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	10:15 AM–11:45 PM	17
	-----BREAK-------	11:45 AM–12:00 PM	18
	SESSION 10: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	12:00 PM–1:30 PM	19
	SESSION 11: ROBOTICS; SECURITY	12:00 PM–1:30 PM	20
	SESSION 12: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	12:00 PM–1:30 PM	21

All the timings are given in Pacific Daylight Time (PDT (UTC−07))

DAY	EVENT DETAILS	TIMING	PAGE NUMBER
DAY 3 (9th JUNE 2023)	KEYNOTE 5: CHALLENGES AND SOLUTIONS OF DEEP LEARNING IN WILDLIFECONSERVATION	8:30 AM–9:15 AM	22
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	-----BREAK-------	10:00 AM–10:15 AM	22
	WORKSHOP ON ASPECTS OF VIRTUAL REALITY	10:15 AM–1:15 PM	24
	SESSION 13: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	10:15 AM–11:45PM	25
	SESSION 14: SECURITY; IoT PROTOCOLS	10:15 AM–11:45PM	26
	SESSION 15: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	10:15 AM–11:45PM	27
	-----BREAK-------	11:45 AM–12:00 PM	27
	SESSION 16: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	12:00 PM–1:30PM	28
	SESSION 17: UBIQUITOUS COMPUTING; IoT TECHNOLOGIES	12:00 PM–1:30PM	29
	SESSION 18: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	12:00 PM–1:30PM	30

All the timings are given in Pacific Daylight Time (PDT (UTC−07))

DAY	EVENT DETAILS	TIMING	PAGE NUMBER
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	KEYNOTE 8: BUILDING CULTURALLY INCLUSIVE AI MODELS	9:15 AM–10:00 AM	31
	-----BREAK-------	10:00 AM–10:15 AM	31
	SESSION 19: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING;AI ALGORITHMS	10:15 AM–11:45 PM	33
	SESSION 20: CAD DESIGN; COMPUTER VISION; NEURAL NETWORKS	10:15 AM–11:45 PM	34
	SESSION 21: APPLICATIONS OF IoT	11:45 AM–12:00 PM	35
	-----BREAK-------	11:15 AM-11:30 AM	35
	SESSION 22: IoT; ARTIFICIAL INTELLIGENCE TOOLS & APPLICATIONS	12:00 PM–1:30 PM	36
	SESSION 23: AI TOOLS & APPLICATIONS; NATURAL LANGUAGE PROCESSING	12:00 PM–1:30 PM	36
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All the timings are given in Pacific Daylight Time (PDT (UTC−07))

SESSION 5: PATTERN RECOGNITION;CLOUD COMPUTING; GRAPHICS			
SESSION CHAIR : RENATO R. MAALIW III (SOUTHERN LUZON STATE UNIVERSITY, PHILIPPINES)			
SESSION TIME: 12:30 PM – 2:00 PM (DAY 1: 7th June 2023)			
PARTICIPATION LINK: https://zoom.us/j/6626883577			
TIME ALLOTTED	**PAPER ID**	**PAPER NAME**	**AUTHORS WITH AFFILIATION & COUNTRY**
12:30 PM – 12:45 PM	1570900370	Pattern Recognition for Hidden Markov Processes: Locality and Accuracy	Shieu-Hong Lin (Biola University, USA)
12:45 PM – 1:00 PM	1570907500	Utilization of EEG and fNIRS to Determine Neural Alignment in Educational Applications	Abel Desoto (California State University of Fullerton, USA)
1:00 PM – 1:15 PM	1570900157	Securing HTTP/3 Web Architecture in the Cloud	Jacob Koch and Emmanuel Kojo Gyamfi (University of Cincinnati, USA)
1:15 PM -1:30 PM	1570907486	Network Function-Enabled Switch for Scalable Network Service Function Chaining	Ning Yang (Southern Illinois University Carbondale, USA); Ning Weng (Southern Illinois University at Carbondale, USA)
1:30 PM – 1:45 PM	1570906378	Improve Decision Making Efficiency in Ridesharing Systems Through a Hybrid Firefly-PSO Algorithm	Fu-Shiung Hsieh (Chaoyang University of Technology, Taiwan)
1:45 PM- 2:00 PM	1570889832	Implementing a Vehicular Communication Network to Minimize Accident-Related Traffic Congestion in the Southern Expressway of Sri Lanka	Oshadhi U Gunathilake, Suvini Malinka De Silva and Sarani Nimhara Kumari (General Sir John Kotelawala Defense University, Sri Lanka); Hiruni Nikeshala (General Sir John Kotelawala Defence University & Hiruni Nikeshala, Sri Lanka); Piumika N Karunanayake (General Sir John Kotelawala Defence University, Sri Lanka)

All the timings are given in Pacific Standard Time (PST (UTC−8))

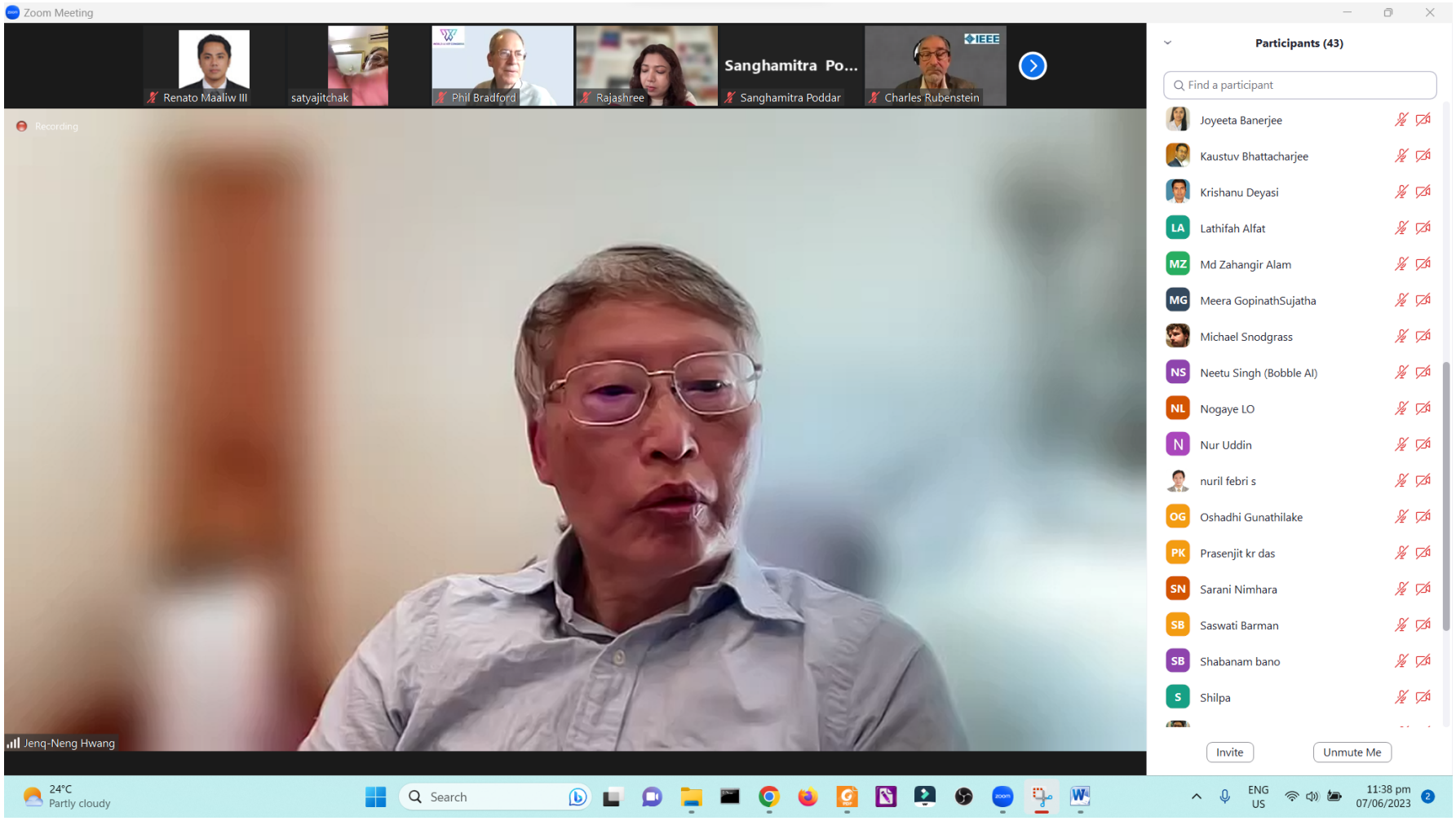
SESSION 9: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING			
SESSION CHAIR : RENATO R. MAALIW III (SOUTHERN LUZON STATE UNIVERSITY, PHILIPPINES)			
SESSION TIME: 10:15 AM – 11:30 PM (DAY 2: 8th June 2023)			
PARTICIPATION LINK: https://zoom.us/j/9587888372			
TIME ALLOTTED	**PAPER ID**	**PAPER NAME**	**AUTHORS WITH AFFILIATION & COUNTRY**
10:15 AM – 10:30 AM	1570906184	Output Feedback Neuroadaptive Control of Electro-Hydraulic Actuators With Constraints	Guichao Yang (Nanjing Tech Universty, China); Zhu Tao (Nanjing Tech University, China)
10:30 AM – 10:45 AM	1570906383	Classification of Corporate Tax Compliance in Indonesia Based on k-Nearest Neighbors Algorithm	Nur Uddin, Agustine Dwianika and Irma Paramita Sofia (Universitas Pembangunan Jaya, Indonesia); Rodrigue Tchamna (The City College of New York, USA)
10:45 AM – 11:00 AM	1570906423	Forecasting the Price of the Flight Tickets Using A Novel Hybrid Learning Model	Rasha Kashef (Ryerson University, Canada)
11:00 AM -11:15 AM	1570906650	A Comparative Study of Detecting Covid 19 by Using Chest X-Ray Images- A Deep Learning Approach	Jonayet Miah (University of South Dakota, USA); Razib Hayat Khan (Independent University Bangladesh, Bangladesh); Md Ishtyaq Mahmud (Central Michigan University, USA); Sabbir Ahmad (University of South Dakota, USA)
11:15 AM – 11:30 AM	1570906749	A Comparative Analysis of Deep Learning Models for Power Quality Disturbance Classification	Sultan Uddin Khan (North Carolina A&T State University, USA); Mohammed Mynuddin (Research Assistant, USA); Dewan Mohammed Abdul Ahad (University of North Carolina at Charlotte, USA); Mohammad Iqbal Hossain (North Carolina Agricultural and Technical State University, USA); Md Jahidul Islam (Tuskegee University, USA); Md Fahad Kabir (Samsung Electronics America, USA)

All the timings are given in Pacific Daylight Time (PDT (UTC−07))

11:45 AM – 12:00 PM	**BREAK**

SESSION 20: CAD DESIGN; COMPUTER VISION; NEURAL NETWORKS			
SESSION CHAIR: IAN BENTLEY (FLORIDA POLYTECHNIC UNIVERSITY, USA)			
SESSION TIME: 10:15 AM – 11:45 PM (DAY 4: 10th June 2023)			
PARTICIPATION LINK: https://zoom.us/j/6626883577			
TIME ALLOTTED	**PAPER ID**	**PAPER NAME**	**AUTHORS WITH AFFILIATION & COUNTRY**
10:15 AM – 10:30 AM	1570901198	Design of Scanning Fiber Micro-Cantilever Based Catheter for Ultra-Small Endoscopes	Mandeep Kaur (Simon Fraser University, Canada); Pierre Lane (BC Cancer Research Center, Canada); Carlo Menon (ETH Zürich, Switzerland)
10:30 AM – 10:45 AM	1570904529	Productivity Improvement by Means of Method Engineering Tools and Automation in Ice Cream Production at Bonanza Company	Edgar W Menendez Elguera, Sofia R Aldana Fernández, Sebastian D Torres Sanchez, Rúben Darío Arzapalo Bello and Nabilt Moggiano (Universidad Continental, Peru)
10:45 AM – 11:00 AM	1570907476	Path Balancing for Reducing Dynamic Power Consumption in Digital Designs Containing IP-Blocks	Noureddine Chabini (Royal Military College of Canada, Canada); Marilyn Wolf (University of Nebraska-Lincoln, USA)
11:00 AM -11:15 AM	1570906076	AWFCNET: An Attention-Aware Deep Learning Network With Fusion Classifier for Breast Cancer Classification Using Enhanced Mammograms	Renato R. Maaliw III (Southern Luzon State University, Philippines); Mukesh Soni (Chandigarh University, India); Manuel P. Delos Santos, Maria Rossana D. De Veluz, Pitz Gerald G. Lagrazon, Mariebeth P. Seño, Devie R. Salvatierra - Bello and Reynaldo V. Danganan (Southern Luzon State University, Philippines)
11:15 AM – 11:30 AM	1570907383	Full Reference Video Quality Assessment Based on Statistical Based Transform Coefficients	Amitesh Kumar Singam (Halmstad University & ACM, India); Wlodek J. Kulesza (Blekinge Institute of Technology, Sweden)
11:30 AM – 11:45 AM	1570907057	Convolutional Neural Network-Based Regression for Direction of Arrival Estimation	Christopher J Bell and Kaushallya Adhikari (University of Rhode Island, USA)

All the timings are given in Pacific Daylight Time (PDT (UTC−07))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Kaustuv Bhattacharjee
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Lathifah Alfat
Md Zahangir Alam
Meera GopinathSujatha
Michael Snodgrass
Neetu Singh (Bobble AI)
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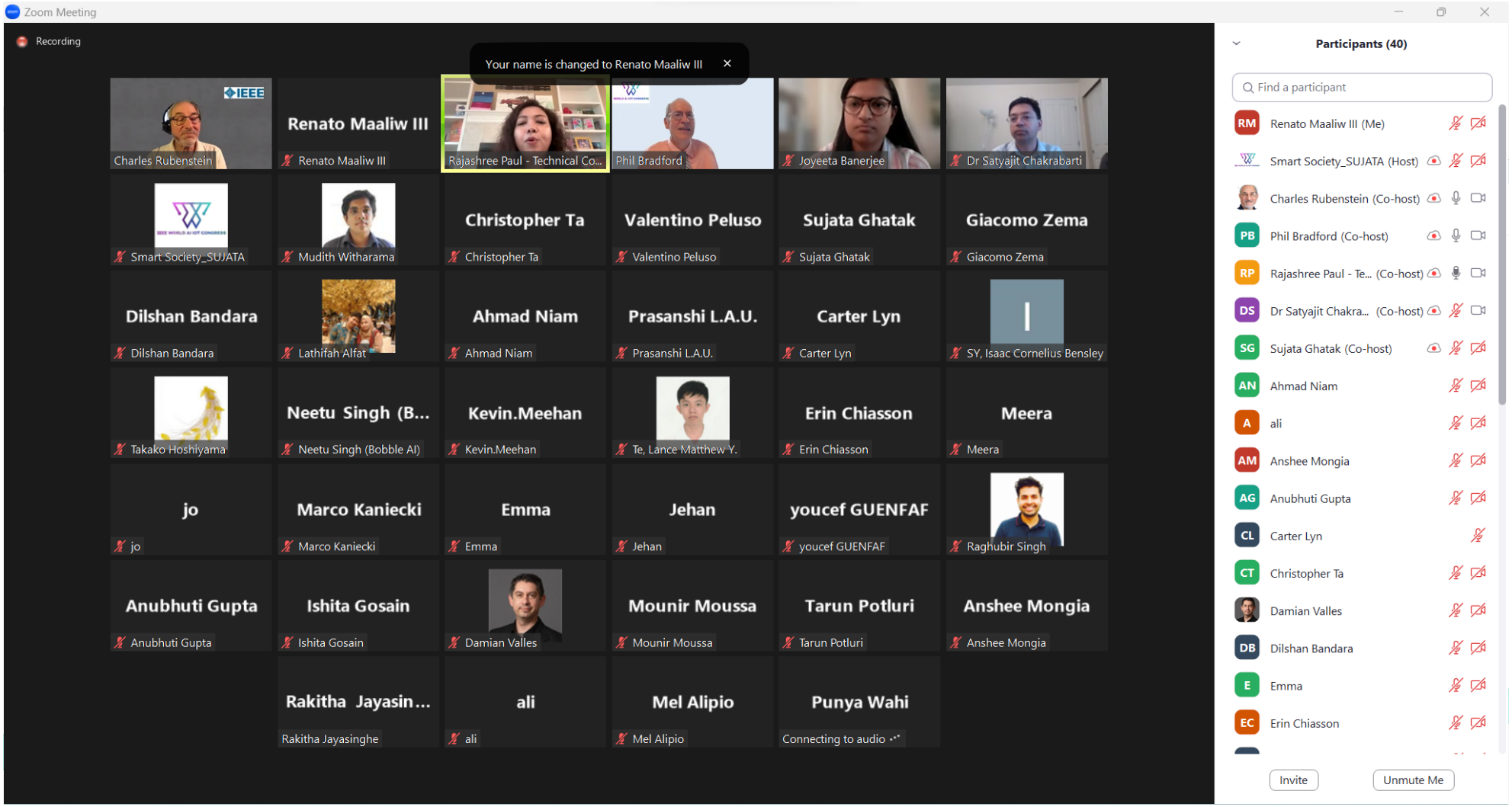
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Charles Rubenstein
Renato Maaliw III
Rajashree Paul - Technical Co...
Phil Bradford
Joyeeta Banerjee
Dr Satyajit Chakrabarti
Smart Society_SUJATA
Mudith Witharama
Christopher Ta
Valentino Peluso
Sujata Ghatak
Giacomo Zema
Dilshan Bandara
Lathifah Alfat
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Anubhuti Gupta
Ishita Gosain
Damian Valles
Mounir Moussa
Tarun Potluri
Anshee Mongia
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Punya Wahi
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Participants (40)
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Renato Maaliw III (Me)
Smart Society_SUJATA (Host)
Charles Rubenstein (Co-host)
Phil Bradford (Co-host)
Rajashree Paul - Te... (Co-host)
Dr Satyajit Chakra... (Co-host)
Sujata Ghatak (Co-host)
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Anubhuti Gupta
Carter Lyn
Christopher Ta
Damian Valles
Dilshan Bandara
Emma
Erin Chiasson
Invite
Unmute Me

AWFCNET: An Attention-Aware Deep Learning Network with Fusion Classifier for Breast Cancer Classification Using Enhanced Mammograms

Renato R. Maaliw III
College of Engineering
Southern Luzon State University
Lucban, Quezon, Philippines

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Mohali, Punjab, India

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Reynaldo V. Danganan
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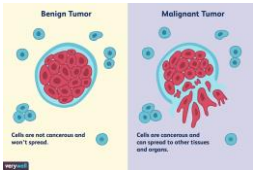
I. INTRODUCTION

Breast cancer (BC) remains a significant public health concern and a leading cause of female mortality despite advances in healthcare.

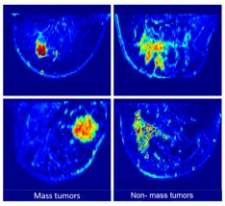
In 2021, 2.5 million breast cancer cases and 630,000 deaths transpired worldwide, 26% of all cancer cases, mostly women.

Despite innovations on interpreting breast cancers using various methods, it is still time-consuming & inconsistent.



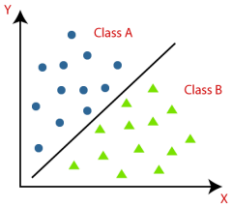
Comparing benign (non-aggressive) and malignant (aggressive) tumors are complex as differences are subtle.

Artificial intelligence approach is paramount to improve prognosis in supporting expert decisions to ensure uniformity, increasing objectivity while decreasing subjectivity.



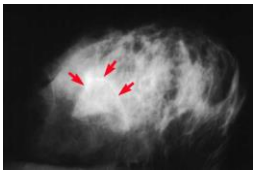
Over the past decades, scientists and professionals experimented with new methods for breast mass segmentations & classifications.

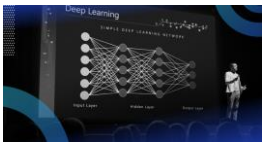
Classical machine learning were used to discriminate between healthy and cancerous samples based on clinical data. However, their accuracies are limited.



Recent deep learning predicated on CNN showed significant improvements but still are limited with the capability to uncover latent image scans.

These dilemmas were due to noisy and hazy image scans contributing to misdiagnosis.



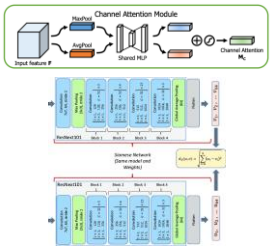


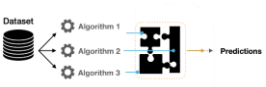
Several scholars have suggested deep neural network layers with classification accuracies ranging from 90% to 97%

Literature analysis reveals that computer-aided diagnostics is progressing swiftly in BC detection incorporating various methods.

However, we are optimistic that there are still unfilled gaps as AI can quickly convey a cancer's finer details better than the naked eye, specifically in its early stages.

To move the science forward, we proposed an automated pipeline based on attention-aware CNN, reinforcement learning and extensive preprocessing procedures.





We also designed a fusion classifier at architecture's end to stabilize classification for a more generalized results.

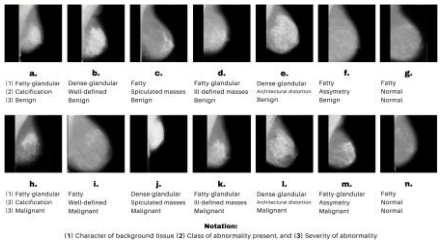
Architecture codename: AWFCNET

Our research can help oncologists evaluate BC earlier to deliver timely patient treatments.

II. METHODOLOGY

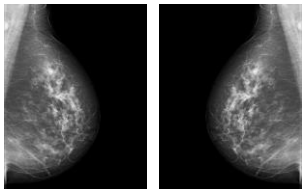
A. Data Source

- **322 high-resolution black-and white mammography scans subdivided into three distinct and equal categories.**
- **64 benign (B), 51 malignant (M), and 207 normal (N).**
- **We obtained additional data to balanced out each category to the size of N (207)**
- **Image sizes are normalized to 512 x 512 to compensate for size differences.**



B. Data Augmentation

1. **We perform a single transformation (horizontal flipping) to generate additional 621 (207 x 3) images with a total of 1242.**
2. **414 for each class (B, M & N)**
3. **We partitioned the final dataset into 80% to 20% training and testing split with a 10-fold cross-validation.**



C. Color Shifting and Image Enhancement

1. **We prioritized green channel (r = 0.19, g = 0.58, blue = 0.23)**
2. **We conducted image enhancement procedures to cure low contrasts, blurry, and noisy images via spatial Wiener filter (SWF) with filter size of 4 x 4.**

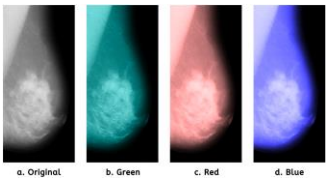


Figure 3. Color shift comparison with reference to the original image (a), where the green channel provided extra details (b) than the others (c & d).

C. Color Shifting and Image Enhancement

1. **We prioritized green channel (r = 0.19, g = 0.58, blue = 0.23)**
2. **We conducted image enhancement procedures to cure low contrasts, blurry, and noisy images via spatial Wiener filter (SWF) with filter size of 4 x 4.**

$$\hat{\sigma}(x,y) = \hat{m}_\eta(x,y) + \frac{\hat{\delta}_\eta^2(x,y)}{\hat{\delta}_\eta^2(x,y) + \hat{\delta}_\varepsilon^2}\,[x(x,y) - \hat{m}_\eta(x,y)] \quad (7)$$

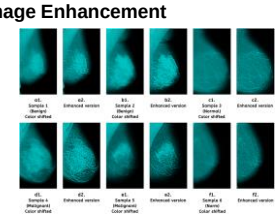


Figure 4. Samples of color shifted (a1 to f1) and enhanced version (a2 to f2) of images with refined breast tissue details using SWF.

D. Residual Network with Exponential Transformations

1. **Our attention-aware CNN's backbone is a ResNeXt.**
2. **Highly effective for allowing diversified and fine-grained feature learning due to its cardinality feature.**
3. **The mechanisms facilitates information flow better with computational efficiency.**

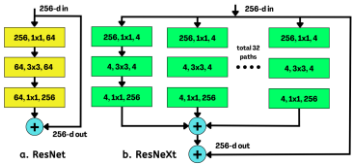
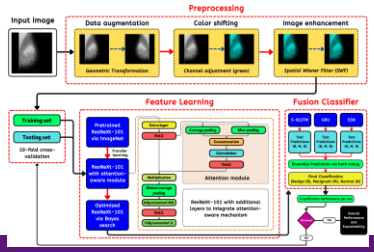


Figure 5. ResNet (a) and ResNeXt (b) with 32 same topology or cardinality.

E. Proposed AWFCNET's Architecture with Fusion Classifier



F. Image Enhancement Metrics

- **Visual information fidelity, a single score to denote overall image quality based on contrasts, sharpness, noise and artifacts using correlation coefficient (CC) and Spearman ranked order CC (SROCC)**
- **0.9 to 1.0 indicates an excellent enhancement values**

$$\mathrm{VIF} = \frac{\sum_{j \in subband} I\left(\vec{C}^{N,j}; \vec{F}^{N,j} \mid s^{N,j} = s^{N,j}\right)}{\sum_{j \in subband} I\left(\vec{C}^{N,j}; \vec{E}^{N,j} \mid s^{N,j} = s^{N,j}\right)} \quad (8)$$

G. Classification Performance Metrics

$$F1 - Score\ (FS) = 2 * \frac{Precision * Recall}{Precision + Recall} \quad (9)$$

$$Precision\ (PR) = \frac{TP}{TP + FP} \quad (10)$$

$$Recall\ (RE) = \frac{TP}{TP + FN} \quad (11)$$

$$Accuracy\ (AC) = \frac{TP + TN}{TP + TN + FP + FN} \quad (12)$$

H. Visual Interpretability

- **We utilized a gradient-weighted class activation mapping (GRAD-CAM++), an extended version of the classic GRAD-CAM that helps capture fine-grained details with generated visual explanations.**

III. RESULTS

A. Hyperparameter Fine-Tuning via Bayes Search

TABLE I. AWFCNET'S OPTIMIZED HYPERPARAMETERS

Hyperparameter	Configuration
Optimizer	ADAM
Learning rate	0.001
Epoch	100
Mini-batch size	64
Loss	Multiclass cross-entropy
Hidden neurons (RNNs)	800
Feature space dimension	256

B. Image Enhancement Performance

- We tested 75 randomly picked images (25) for each group (B, M, N), values exhibit mammogram detailed refinement while keeping breast tissue structure.

TABLE II. IMAGE ENHANCEMENT MEAN QUALITY INDEX (N = 75)

Method	CC	SROCC
VIF	0.961	0.958

C. Overall Classification Performances

TABLE III. AWFCNET'S CLASSIFICATION PERFORMANCE (10-FOLD)

Fold	Accuracy	F1-Score	Precision	Recall
1	0.975	0.964	0.963	0.961
2	0.978	0.977	0.977	0.978
3	0.975	0.975	0.975	0.975
4	0.981	0.981	0.982	0.981
5	0.983	0.983	0.984	0.983
6	0.987	0.987	0.988	0.987
7	0.983	0.968	0.954	0.983
8	0.987	0.988	0.988	0.988
9	0.983	0.984	0.986	0.983
10	0.982	0.989	0.989	0.989
Mean	**0.981**	**0.980**	**0.979**	**0.981**

D. Influence of SWF and Attention Aware Mechanism on Architecture's Performance

TABLE IV. COMPARATIVE PERFORMANCE ON THE ABSENCE OR PRESENCE OF SPECIFIC MECHANISMS ON AWFCNET (10-FOLD)

Mechanism	Accuracy	F1-Score	Precision	Recall
No SWF & No A-ACNN	0.884	0.881	0.881	0.878
No SWF & with A-ACNN	0.912	0.905	0.889	0.917
With SWF & No A-ACNN	0.948	0.949	0.946	0.948
With SWF & with A-ACNN	**0.981**	**0.980**	**0.979**	**0.981**

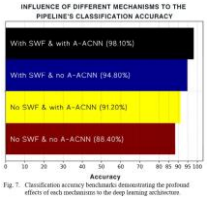


Fig. 7. Classification accuracy benchmarks demonstrating the profound effects of each mechanisms to the deep learning architecture.

E. Fusion Versus Individual Classifier Performance

TABLE V. COMPARATIVE PERFORMANCE OF INDIVIDUAL AND FUSION CLASSIFIERS ON AWFCNET, WITH SWF & WITH A-ACNN (10-FOLD)

RNN Classifier	Accuracy	F1-Score	Precision	Recall
GRU_1	0.931	0.929	0.923	0.932
ESN_2	0.939	0.938	0.936	0.937
$S\text{-}BLSTM_3$	0.968	0.967	0.968	0.963
$Fusion_{(1,2,3,4)}$	**0.981**	**0.980**	**0.979**	**0.981**

Fusion outperforms individual models of GRU, ESN, and S-BLSTMs

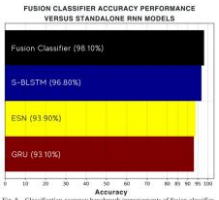


Fig. 8. Classification accuracy benchmark improvements of fusion classifier against individual RNN models.

F. Model Convergence Testing

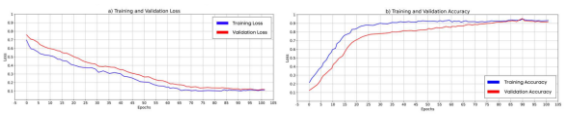
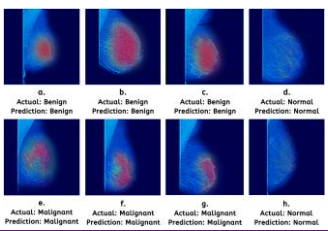


Fig. 9. The graphs demonstrated convergences conveying the lowest probability of overfitting and underfitting.

G. Visual Explainability via GRAD-CAM++

- The red and orange (warmer colors) regions have higher activation values (ACV) that corresponds to the image's most significant areas influencing the CNN's prediction.



H. Benchmarks with Existing (Recent Methods, last 5 years)

TABLE VI. COMPARISON WITH EXISTING DEEP LEARNING-BASED BREAST CANCER CLASSIFICATION MODELS

Models/Architectures/Approaches/Mechanisms	Accuracy
CNN + US-ELM [16]	0.865
VGG-16 + Transfer learning [21]	0.940
Modified AlexNet [22]	0.957
Lightweight CNN [23]	0.836
ELM [24]	0.960
CNN + Feature wise preprocessing [27]	0.905
CNN + Parasitic metrics layers [28]	0.967
Mixture Ensemble CNN [29]	0.963
CNN + Marine predators algorithm [30]	0.983
Multi-DCNNs [31]	0.974
Multi-DCNNs + PCA [33]	0.979
Modified CNN + Texture feature approach [34]	0.978
SWF image enhancement + transfer learning + attention-aware CNN + fusion RNN classifiers (AWFCNET, our model)	**0.981**

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IV. DISCUSSIONS

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This study presented a comprehensive deep learning architecture with multiple preprocessing & special mechanisms.

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Empirical results indicate that our framework outperforms traditional and existing methods for BC sub-type identification with 98.10% accuracy, 98% (f1-score), 97.90% (precision), and 98.10% (recall) – indicating robust efficacy.

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Color shifting and SWF preprocessing contributed to its accuracy with increase visual clarity without changing the overall structural characteristics of raw mammogram based on VIF scores.

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The ResNeXt-101 with cardinality module overcame the challenges in extracting the minuscule morphological heterogeneity of tumors.

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The addition of attention-aware module in the neural network's designed reinforced feature learning by concentrating in regions of interests with subtle yet granular tissue differences.

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The integration of fused RNN classifier at the end of the pipeline complemented the spatial learning capabilities of our AWFCNET by recognizing critical temporal dependencies in data.

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GRAD-CAM++ provided visual interpretability that is consistent with experts description of benign and malignant tumors.

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This study did not explore data set for a general population that considers ethnicity, race, socioeconomic background and other related variables.

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IV. CONCLUSIONS

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Cancer is a debilitating illness affecting millions globally and remains the most pressing public health concern.

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As we look ahead, it is clear that continuous research and innovation are essential to combat the disease.

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We developed AWFCNET, a comprehensive machine learning model with various features for BC classification

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Our extensive experiments revealed its exceptional accuracy rate in pinpointing BC sub-types compared with existing state-of-the-art approaches.

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It should be noted that combination of human expertise and machine learning could significantly lower diagnostic errors even in the early stages of BC when it is still treatable for patient's effective treatment plans..

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For future work, the authors plan to improve the model's accuracy by exploring generative adversarial networks and transformers.

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Thank you very much for listening.

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#115 (1570906076): *AWFCNET: An Attention-Aware Deep Learning Network With Fusion Classifier for Breast Cancer Classification Using Enhanced Mammograms*

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Paper title	*AWFCNET: An Attention-Aware Deep Learning Network With Fusion Classifier for Breast Cancer Classification Using Enhanced Mammograms* Only the chairs can edit
Conference and track	**2023 IEEE World AI IoT Congress (AIIoT)** - *2023 IEEE World AI IoT Congress (AIIoT) Regular Research Paper*
Abstract	Only the chairs can edit Breast cancer remains a significant public health concern and a leading cause of female mortality...
Keywords	ensemble prediction; hybrid model; image enhancement; medical diagnosis; ResNeXt-101; tumors Only the chairs can edit
Topics	Computer Vision and Speech Understanding; Pattern Recognition (Only the chairs can edit)
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Presentation	Final manuscript

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completed

Comments

The paper should be accepted in its current form.
However, the authors did not anonymize themselves in the paper.

completed

Comments

- The paper proposes a deep learning architecture called AWFCNET for breast cancer classification.
- Experimental results show that the proposed approach outperforms existing methods.
- There is a need to use a larger dataset.
- Add a block diagram in section II to show the proposed method.

completed

Comments

Authors are requested to change the title.
The title seems too long and it is very hard to get the paper topics.
Too many references are cited. If possible, remove some unnecessary.