



Lung Cancer Detection On CT-Scan Images With Deep Learning Methods: Sugeno Fuzzy Integral-based CNN Ensemble

Lim Soong Xian¹ & Masita @ Masila binti Abdul Jalil² *
^{1,2} Faculty of Ocean Engineering Technology & Informatics,
Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.

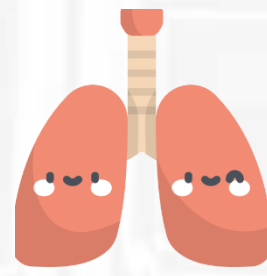


STUDENT
RESEARCH
DAY @UMT 2022
26 June 2022 | Living into the Endemic
era of COVID-19

SRD-05

INTRODUCTION

- LUNG CANCER** is the leading cause of death (1.80 million) in 2020.
- All convolutional neural network (CNN) model in deep learning currently has their own weaknesses.
- Existing study are not ideal as most use single CNN model detection method.
- This study is to propose a **better approach for lung cancer detection** with a higher accuracy through multiple CNN models with Sugeno fuzzy ensemble.
- From the best of my knowledge, this is the first research using this proposed approach.



OBJECTIVES



To study the accuracy of Sugeno fuzzy ensemble combined with CNN models to assist in lung cancer detection.

To evaluate whether Sugeno fuzzy ensemble combined with CNN models outperform existing methods.

To develop a prototype of lung cancer detection using Sugeno fuzzy ensemble combined with CNN models.

METHODOLOGY

Transfer Learning

CNN Model

VGG-11

GoogLe Net

Squeeze Net v1.1

Wide ResNet-50-2

- ★ Feature Extraction
- ★ Feature Selection

Performance Measure and Comparison

Confusion Matrix

$$\text{Accuracy} = \frac{\text{Correct Detection (TP + TN)}}{\text{All Detection (TP + TN + FP + FN)}}$$

$$\text{Precision} = \frac{\text{True Positive (TP)}}{\text{Total Positive Prediction (TP + FP)}}$$

$$\text{Recall} = \frac{\text{True Positive (TP)}}{\text{Total Actual Positive (TP + FN)}}$$

$$F - \text{Measure} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

Data Collection

Transfer Learning

Data Pre-processing

Ensemble

Performance Measure and Comparison

RESULTS AND DISCUSSION

Results

Proposed Approach

- Accuracy: 99.58%
- Precision: 99.54%
- Recall: 99.51%
- F1-Score: 99.51%

VGG-11

Accuracy: 97.54%
Time Taken: 62m 29s

GoogLeNet

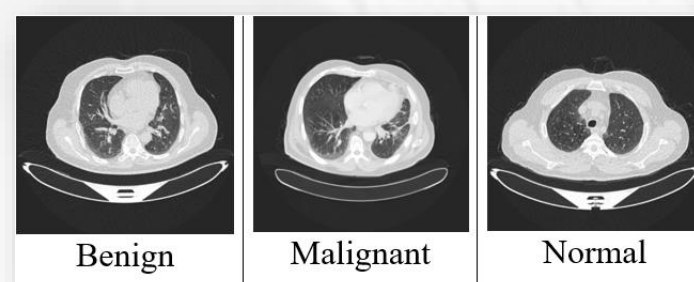
Accuracy: 99.02%
Time Taken: 32m 52s

SqueezeNet v1.1

Accuracy: 91.67%
Time Taken: 32m 25s

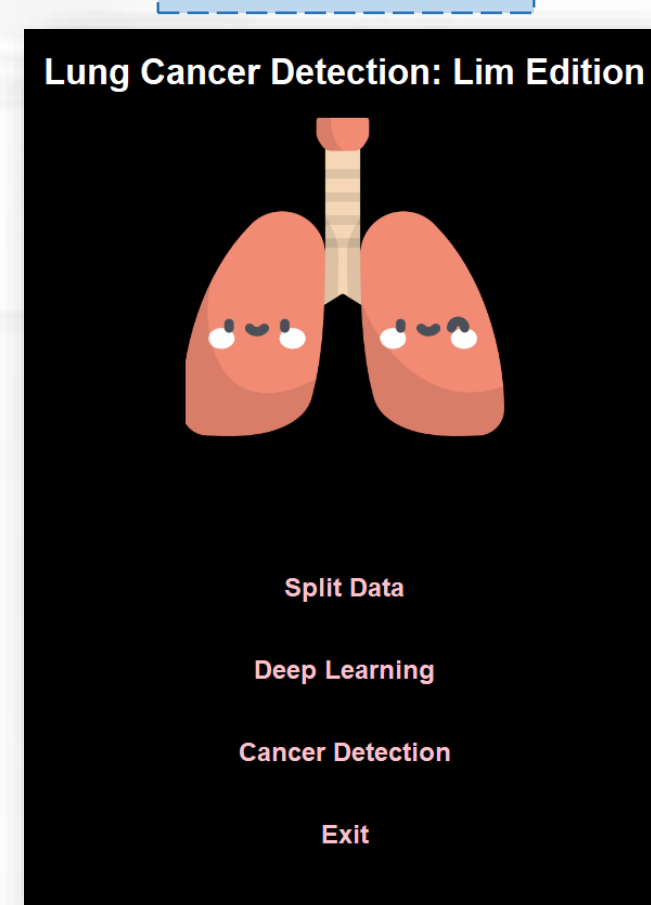
Wide ResNet-50-2

Accuracy: 99.51%
Time Taken: 98m 22s



		Predicted		
		Benign	Malignant	Normal
Actual	Benign	18	0	0
	Malignant	0	107	0
	Normal	1	0	78

User Interface



Discussion

Comparison with Existing Studies

Title	Accuracy (%)
Proposed Approach	99.58% ★
Comparison of deep learning convolutional neural network (CNN) architectures for CT lung cancer classification	GoogLeNet: 94.53 SqueezeNet: 94.13 ShuffleNet: 92.91 DenseNet: 93.52 MobileNetV2: 92.91
Diagnosis of lung cancer based on CT scans using CNN	93.55
Lung Nodule Detection in Computed Tomography Scans Using Deep Learning	96.00
Transfer learning with GoogLeNet for detection of lung cancer	94.38

- Proposed approach provides the **highest accuracy** compared to existing study, 99.58%
- The individual model with the highest accuracy is Wide ResNet-50-2 with 99.51%.
- Total time taken for training and validation is 227min 6s.

CONCLUSION

Final Accuracy: 99.58%

This study can be converted into a program as a useful tools for aiding medical practitioner to identify patients suffering from lung cancer.

Sugeno fuzzy ensemble approach with the four CNN models improves the overall performance of lung cancer detection.

This study provide new techniques in artificial intelligence for medical practitioners and the medical industry

For future works, this Sugeno fuzzy ensemble approach may be used with only GoogLeNet and Wide ResNet-50-2 to validate if the accuracy exceeds current research.

REFERENCES

- AL-Huseiny, M. S., & Sajit, A. S. (2021). Transfer learning with GoogLeNet for detection of lung cancer. *Indonesian Journal of Electrical Engineering and Computer Science*, 22(2), 1078. <https://doi.org/10.11591/ijeecs.v22.i2.pp1078-1086>
- Covid-19 detection from lung CT-scans using a fuzzy integral-based CNN ensemble. *Computers in Biology and Medicine*, 138, 104895. <https://doi.org/10.1016/j.compbiomed.2021.104895>
- World Health Organization. (2022, February 3). Cancer. World Health Organization. Retrieved June 10, 2022, from <https://www.who.int/news-room/fact-sheets/detail/cancer>

FTKKI



Terokaan Seluas Lautan, Demi Kelestarian Sejahtera | Ocean of Discoveries for Global Sustainability