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# Vision-based Assistance for Vocal Fold Identification in Laryngoscopy with Knowledge Distillation


Thao Dao

- *Graduate Student in Information & Communication Technology - Artificial Intelligence*
  University of Science - Vietnam National University - Vietnam
- *Otolaryngologist*
  Thong Nhat Hospital – Vietnam




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# Vision-based Assistance for Vocal Fold Identification in Laryngoscopy with Knowledge Distillation

Thao Dao[1,2,3,4], Minh-Khoi Pham[1,2], Mai-Khiem Tran[1,2,3], Bich Tran[5], Ngoc Van[6], Chanh Cong[7], Minh-Triet Tran[1,2,3]
[1]University of Science, Ho Chi Minh City, [2]Viet Nam National University, Ho Chi Minh City, [3]John von Neumann Institute,
[4]Thong Nhat Hospital, [5]Cho Ray Hospital, [6]Vinmec Central Park International Hospital, [7]7A Military Hospital

# OUTLINE

1. Introduction
2. Dataset and Evaluate on backbones
3. Implement knowledge distillation
4. Portable laryngoscope with AI smart assistance

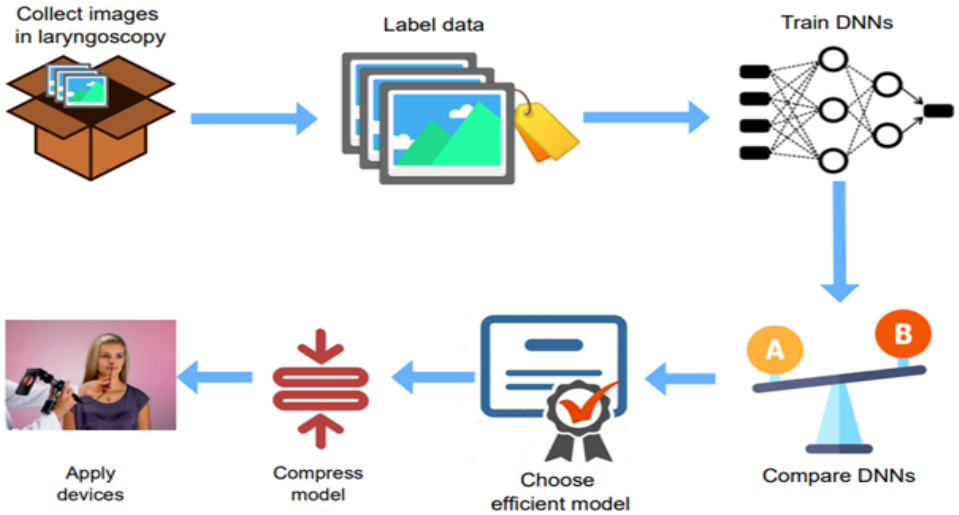
# I. Introduction

## ❖ Purposes

- Introduce a **novel dataset** about vocal fold images, along with baseline performance and metrics on a number of backbones.
- Propose a **lightweight network** using **knowledge distillation**.
- Propose a solution of **AI assistance on smartphones** for **laryngoscopy**.

# I. Introduction

- Overview of our process




Develop a smart vision-based assistance for vocal fold detection and localization

# II. Dataset and Evaluate on backbones

## ❖ Dataset

- **Collect 4,624 images** of 876 different patients

  at Department of Otorhinolaryngology, Cho Ray Hospital.

- **Filter samples** to discard noisy images.

- **Two junior ENT doctors independently label** images

  after that **revise** once again by **an expert**.

# II. Dataset and Evaluate on backbones

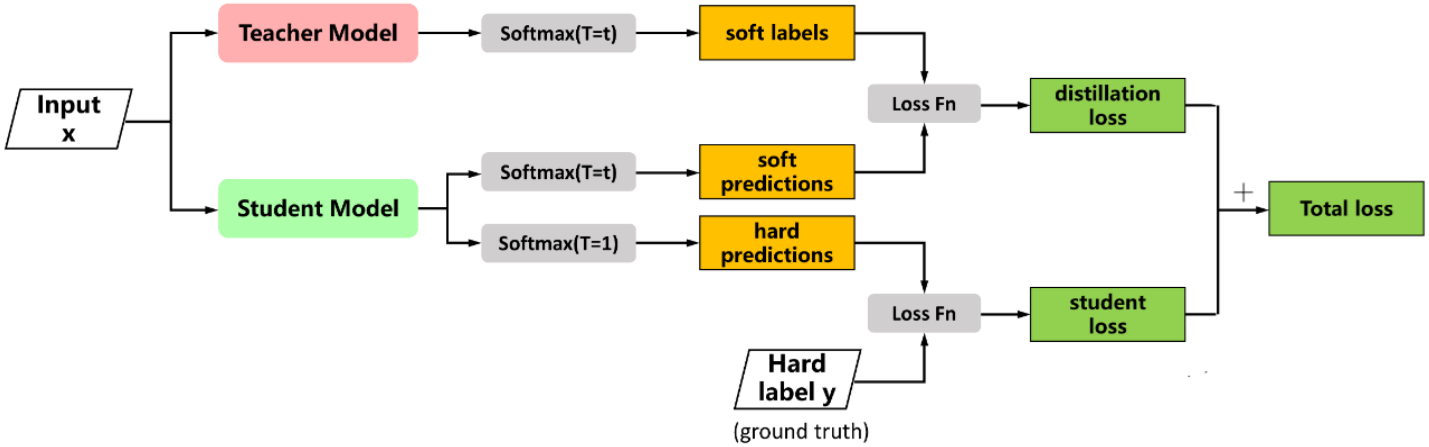
- Evaluate on backbones

**EfficientNetB1** shows extremely **effective** results in assessing images of vocal fold appearance.

| | VGG19 | ResNet50V2 | MobileNetV2 | InceptionV3 | DenseNet201 | Xception | EfficientNetB1 |
|---|---|---|---|---|---|---|---|
| **Accuracy (%)** | 91.8 | 98.5 | 96.1 | 98.3 | 98.2 | 98.2 | **98.7** |
| **Recall (%)** | | | | | | | |
| Non vocal fold | 94.2 | 98.8 | 96.7 | 98.3 | 98.3 | 98.5 | **99.2** |
| Vocal folds | 88.7 | 98.0 | 95.3 | **98.3** | 98.0 | 97.8 | 98.0 |
| **Precision(%)** | | | | | | | |
| Non vocal fold | 91.4 | 98.5 | 96.4 | **98.6** | 98.5 | 98.3 | 98.5 |
| Vocal folds | 92.3 | 98.5 | 95.8 | 97.8 | 97.8 | 98.0 | **99.0** |

# III. Implement knowledge distillation

## ❖ Overview Knowledge Distillation

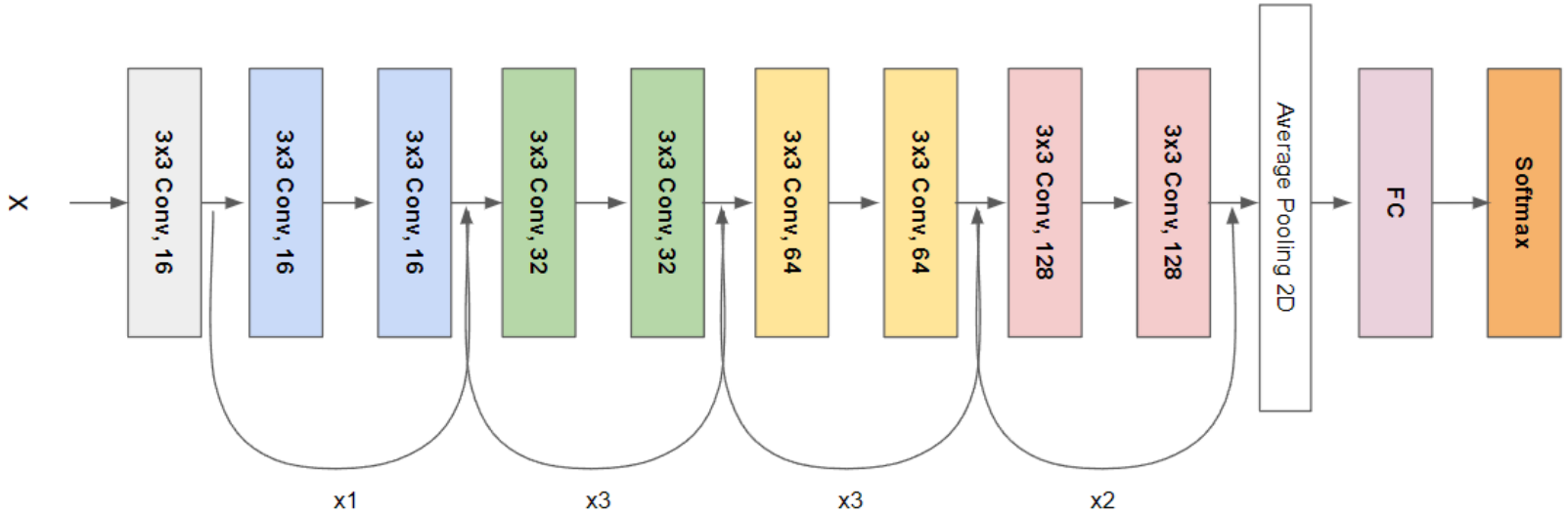



$$\alpha * CE(y_{gt}, y_s) + (1 - \alpha) * KL(y_t, y_s)$$

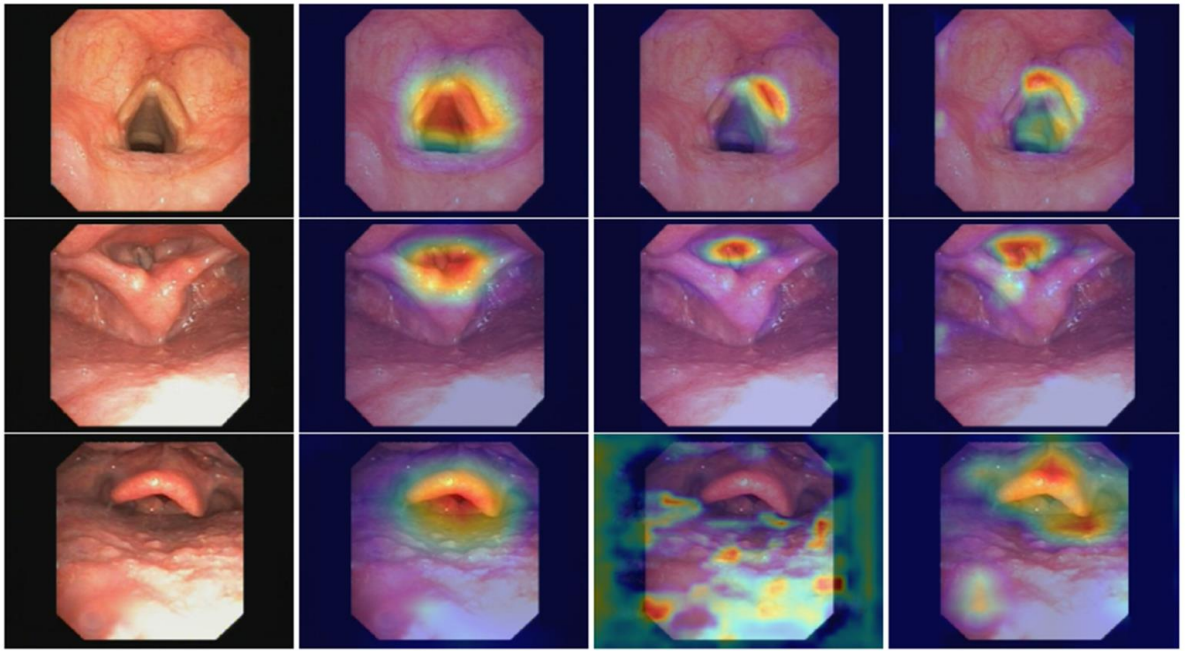
with $KL(y_t, y_s) = F(y_t) \times log(\frac{F(y_t)}{F(y_s)})$

# III. Implement knowledge distillation

- Architecture of our simple ResNet distilled



# III. Implement knowledge distillation



(a) Input image (b) EfficientNetB1 (c) Simple-ResNet-Scratch (d) Simple-ResNet-Distilled

# III. Implement knowledge distillation

Distillation helps:

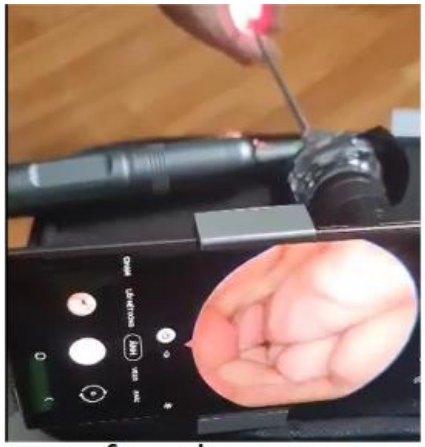
- The student's performance to **approximately match the teacher**'s one.
- **Faster convergence.**
- Require **minimal computing resource**.

| Methods | Accuracy | No. parameters |
|---|---|---|
| EfficientNet-B1 | 98.7% | 6.7M |
| MobileNetV2 | 96.1% | 2.4M |
| Simple-ResNet-Scratch | 96.7% | 0.8M |
| Simple-ResNet-Distilled | 98.4% | 0.8M |

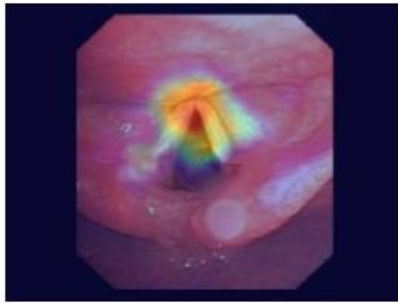
# IV. Portable laryngoscope with AI smart assistance

- A system apply our **distilled deep learning model** to **portable laryngoscopy devices**.
- This system includes:
  - ✓ Mobile application that integrates our distilled model.
  - ✓ Smartphone.
  - ✓ Endoscope adaptor.
  - ✓ Light source.
  - ✓ Laryngeal endoscope.

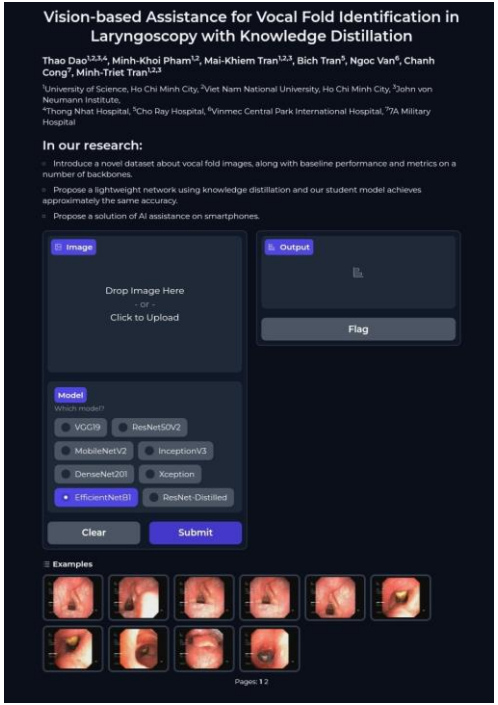
# IV. Portable laryngoscope with AI smart assistance

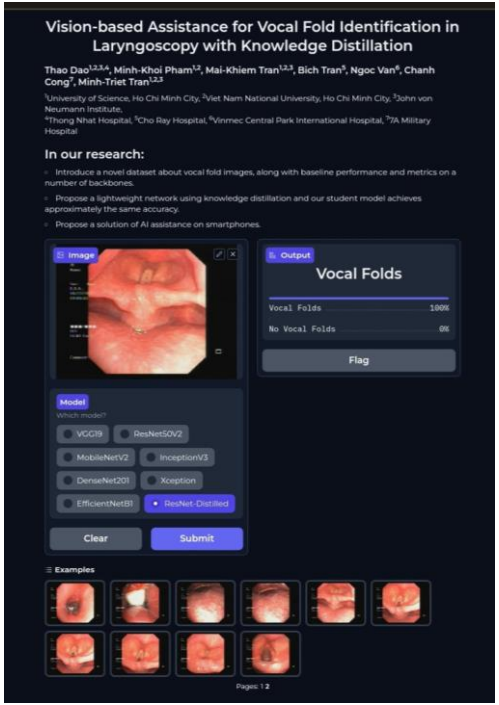


Images from laryngoscope connected to smartphone



Vocal folds located in image in realtime






http://thevncore-lab.mooo.com:20778/

# Summary

- A **novel dataset** about the laryngscopy images.
- A **suitable model** for applying **knowledge distillation**.
- **AI assistance on smartphones** to create a portable laryngoscope system.

# Thanks for your attention