Mirror, Mirror on the Wall: Automating Dental Smile Analysis in Smart Mirrors with CNN and Diffusion Model

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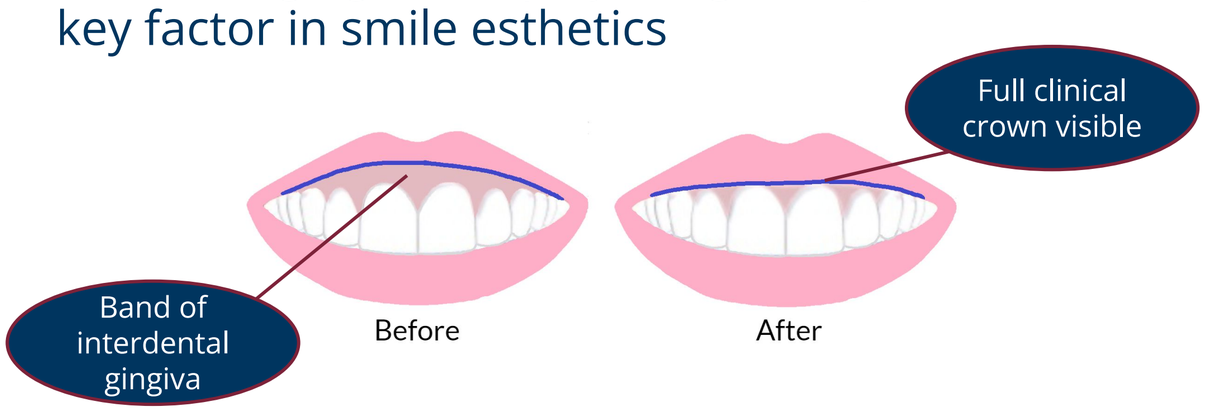
A smart diagnostic framework for dental smile analysis.

Introduction

- Advancements in **IoT** and **ML**, particularly within **connectivity** and **CV**, are increasingly being applied in the **medical field**
- Few digital applications in the **dental sector**
- Many CV-related tasks in healthcare are limited by **small datasets**

Background:

- **Smile analysis**, the combination of factors making up the "perfect" smile, is diagnosed by a dentist **affects a person's mental and physical health**
- Excessive gingival display or **"gummy smile"** is a key factor in smile esthetics



Current Drawbacks:

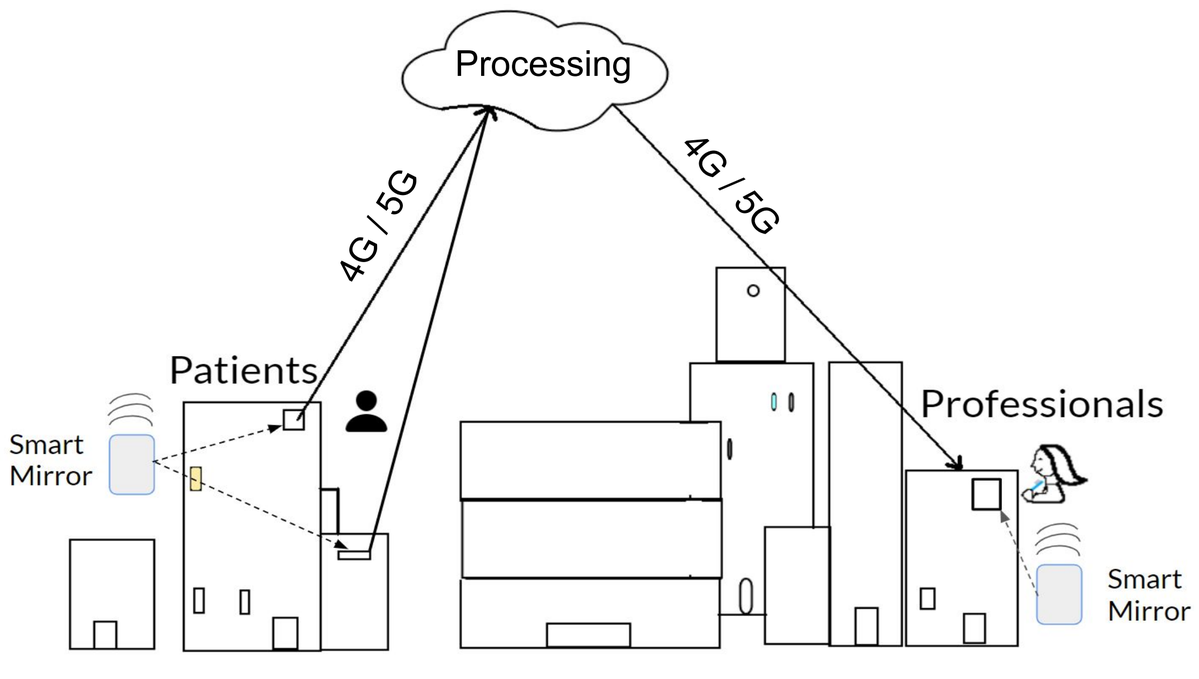
Latency **Subjectivity** **No diagnostic tool**

Contributions

- **Novel diagnostic smile analysis tool:** a CNN model trained on different proportions of real and generated images to detect excessive gingival display
- **Dental smile dataset:** a dataset of 512 labeled dental smile images; 256 real images and 256 diffusion model generated

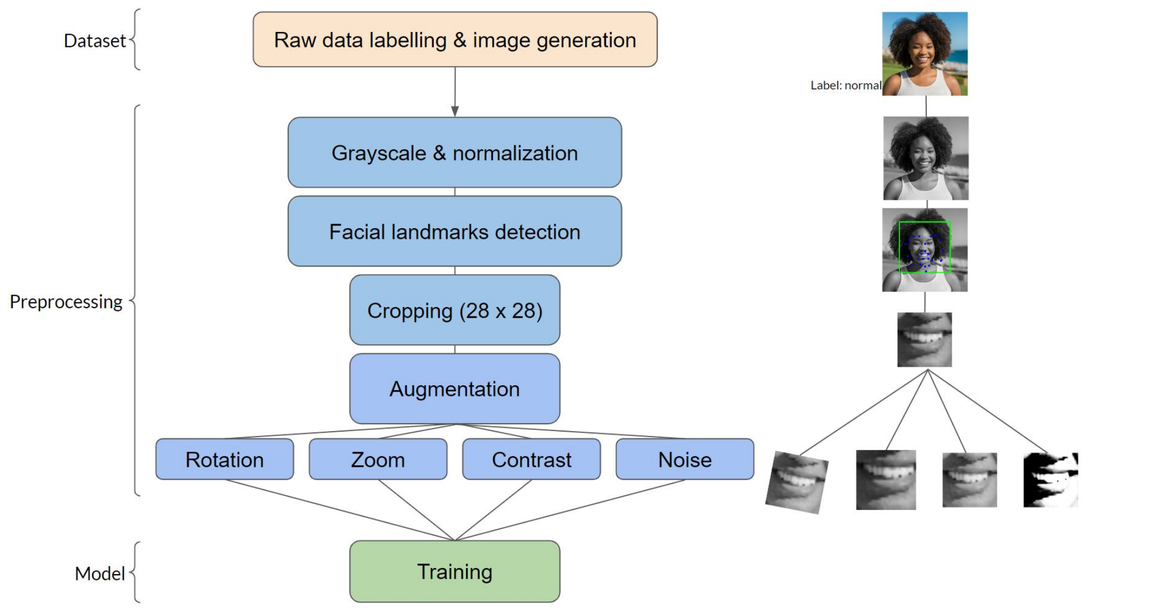
- **Internet-of-Mirrors integration vision:** a visionary system of interconnected smart mirrors

Goal: resolve traditional smile analysis limitations with an end-to-end assistive diagnostic application.

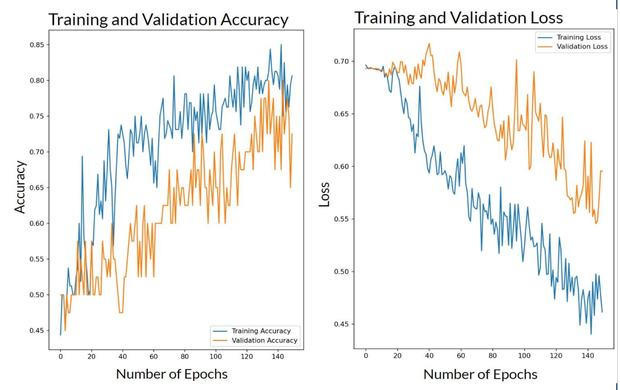


Methodology

- Sequential CNN model trained on 2 classes: **gummy & normal**
- The same architecture on 3 datasets: **all real** **all generated** **1:1 real:generated**
- Generated data from Adobe Firefly's diffusion model with consistent prompts for portraits
- Uniform preprocessing with augmentation
  - No user face data is stored other than cropped mouth images

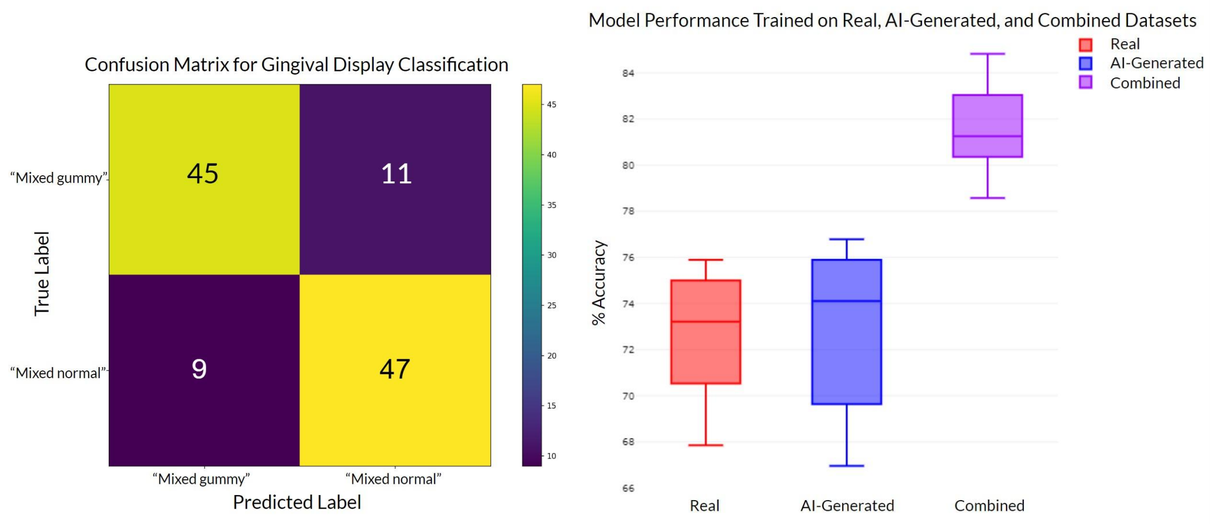


- Trained CNN with tuned hyperparameters and Adam optimizer on 28x28 preprocessed mouth images



Results

- Best performing model: **1:1 real:generated** at **81.61%** average accuracy (p-value>0.01); **F1=0.82**
- Mixed dataset model performs significantly better



Conclusion and Extension

Takeaway 1: we can use a CNN for automatic dental diagnosis and connecting patients with professionals.
Takeaway 2: scarce dental smile data can be successfully augmented by adding generated images to the dataset to achieve higher performance.

- Test on real data
- Compare convergence rates between datasets
- Classify more smile analysis factors (e.g. smile arc)