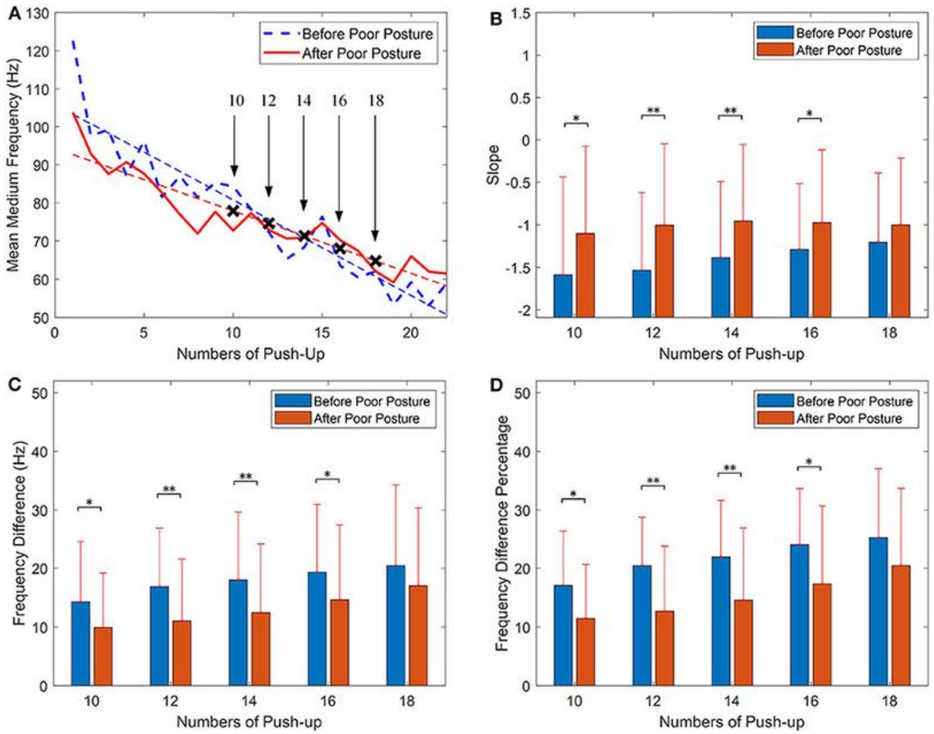

La Salle College

# PosturePal

## 姿勢好幫手

# Why should we sit correctly?

- **Chronic back** and **neck pain**
- Increased risk of **musculoskeletal disorders**
- **Stress**, **reduced self-esteem**, and productivity
- Even **cancer** or **heart diseases** in the long term*




*Department of Health & Human Services. (n.d.). The dangers of sitting: why sitting is the new smoking. Better Health Channel. https://www.betterhealth.vic.gov.au/health/healthyliving/the-dangers-of-sitting

# Status Quo

- **Poor awareness** of posture habits
- **Lack of accessible tools** for correction
- **Low motivation** due to work/study pressures, especially **students**
- Cycle of neglect worsening symptoms

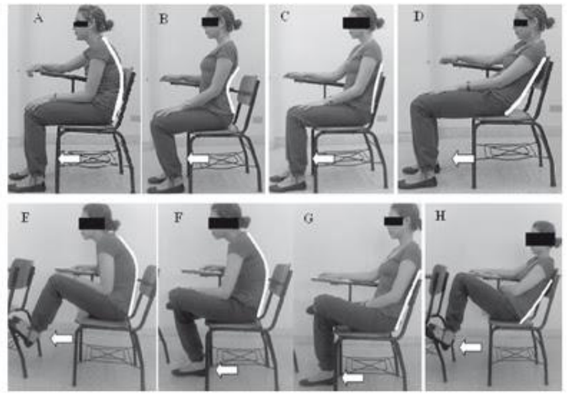



**Figure 1.** Sitting posture categories (A) Rounded back or increase of the kyphosis with the feet supported on the floor; (B) Increase of the lordosis and the feet supported on the

| | Mean ± SD | Minimum-Maximum. |
|---|---|---|
| BackPEI posture score | 1.42 ± 0.98 | 0-5 |
| | n | % |
| Sitting posture while listening teacher on desk | | |
| Correct body posture | 312 | 14.0 |
| Poor posture | 1,909 | 86.0 |
| Sitting posture while writing on desk | | |
| Correct body posture | 75 | 3.4 |
| Poor posture | 2,146 | 96.6 |
| Sitting posture while using computer | | |
| Correct body posture | 338 | 15.2 |
| Poor posture | 1,883 | 84.8 |
| Posture while grabbing something on the floor | | |
| Correct body posture | 928 | 41.8 |
| Poor posture | 1,293 | 58.2 |
| Posture while carrying a school backpacks* (n = 2,036) | | |
| Correct body posture | 1,448 | 71.1 |
| Poor posture | 588 | 28.9 |

SD = standard deviation.
* Adolescents who carry a school backpacks.

# Existing Solutions

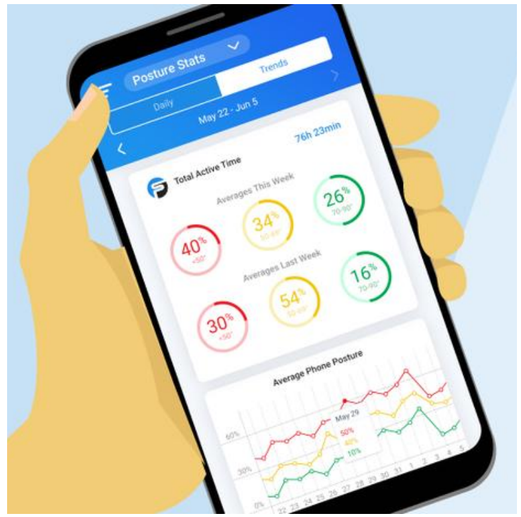
## Ergonomic furnitures

**High cost**
**Passive support**

## Wearable devices

**Diminishing effectiveness**
**Comfort issues**

## Posture Monitoring Apps

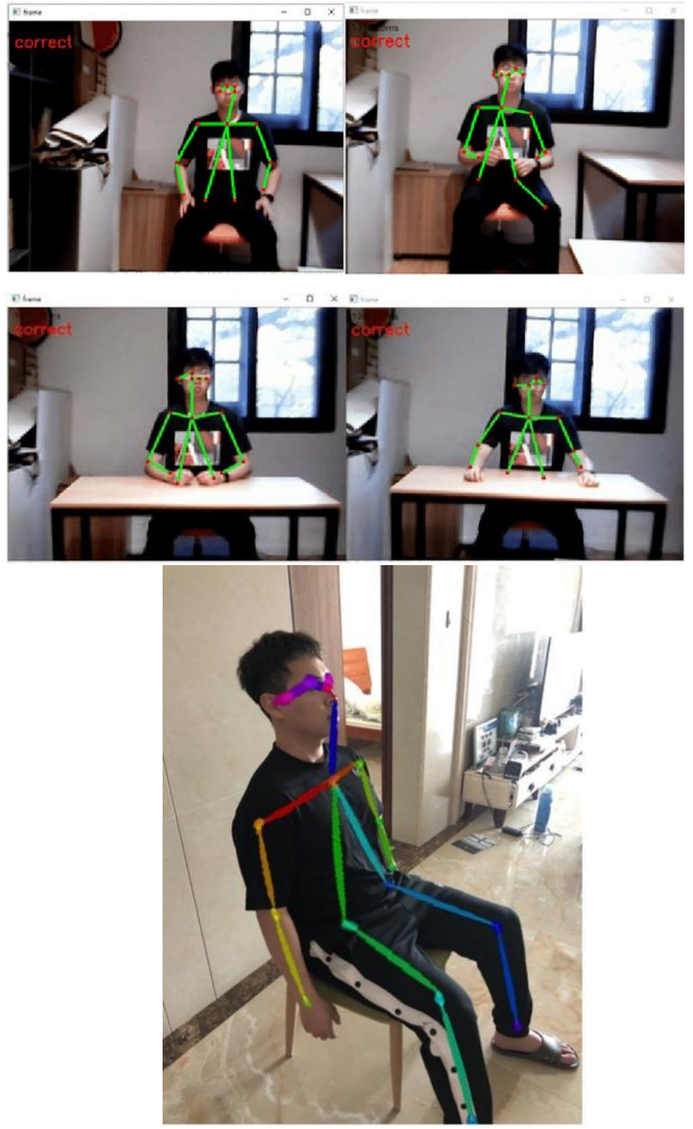



**Generic feedback**
**Engagement challenges**

# Our Solution

# PosturePal

- **AI**-driven
- **Sensors + AI algorithms + Large Language Models (LLM)**
- **Humorous** Feedback
- Focuses on **“Fun”**

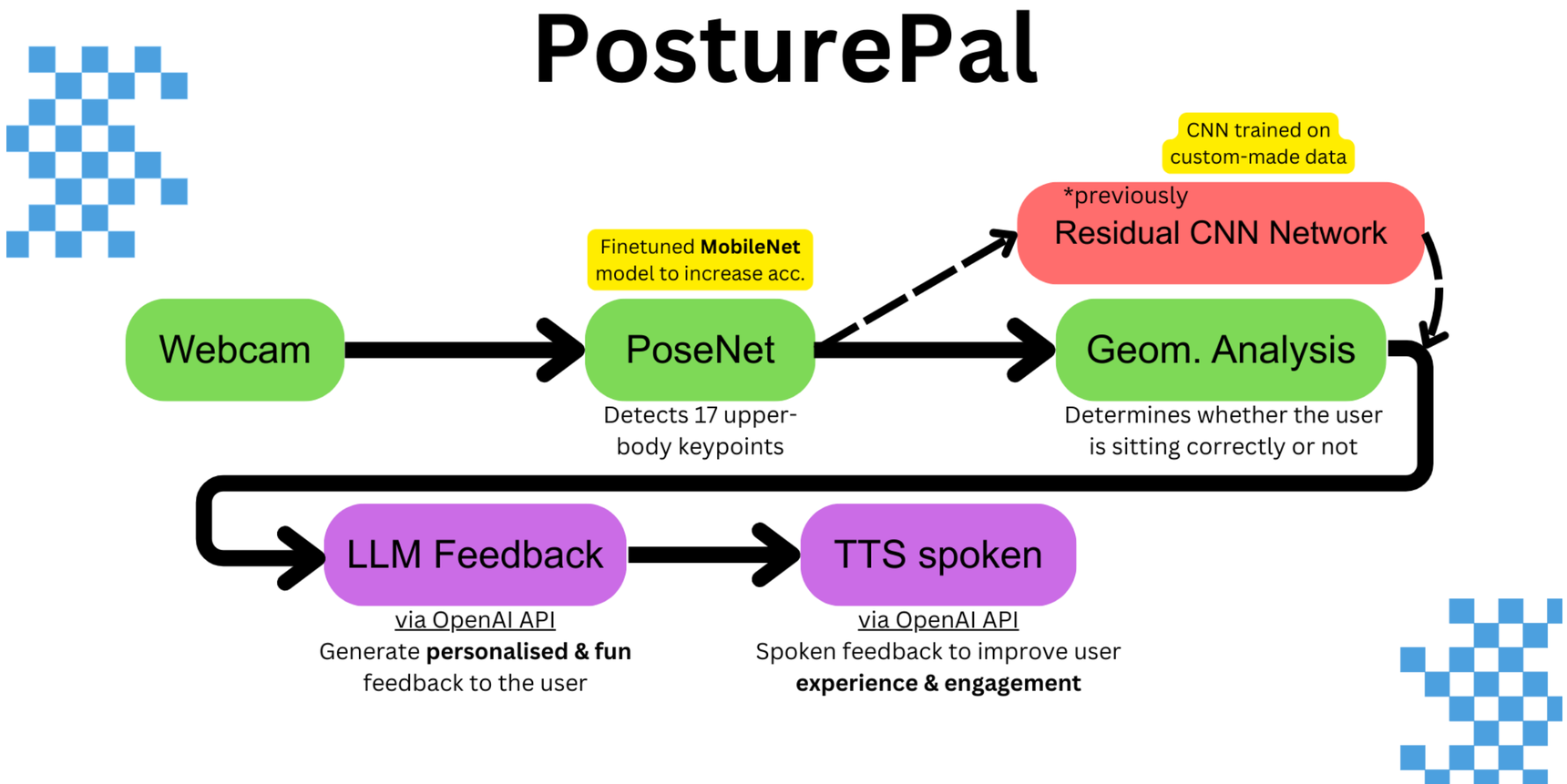


# Advantages of PosturePal

- Personalization
- User Engagement
- Sustainability
- Accessibility
- Feedback Mechanism

# Prototype Development

# How It Works

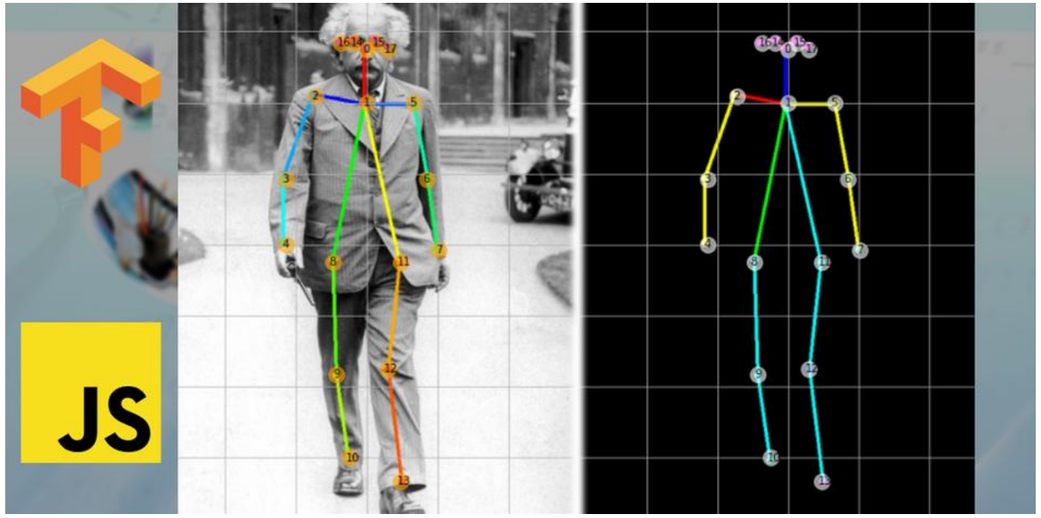

PosturePal
CNN trained on custom-made data
*previously
Residual CNN Network
Finetuned **MobileNet** model to increase acc.
Webcam
PoseNet
Geom. Analysis
Detects 17 upper-body keypoints
Determines whether the user is sitting correctly or not
LLM Feedback
TTS spoken
via OpenAI API
Generate **personalised & fun** feedback to the user
via OpenAI API
Spoken feedback to improve user **experience & engagement**

# How It Works

- Detect the user’s posture with a **finetuned PoseNet**
- Analysation with our **custom model**
- Send the analysed results to the LLM for **personalized & fun reminders**
- Read the LLM’s results with text-to-speech (TTS)

# Detection - PoseNet

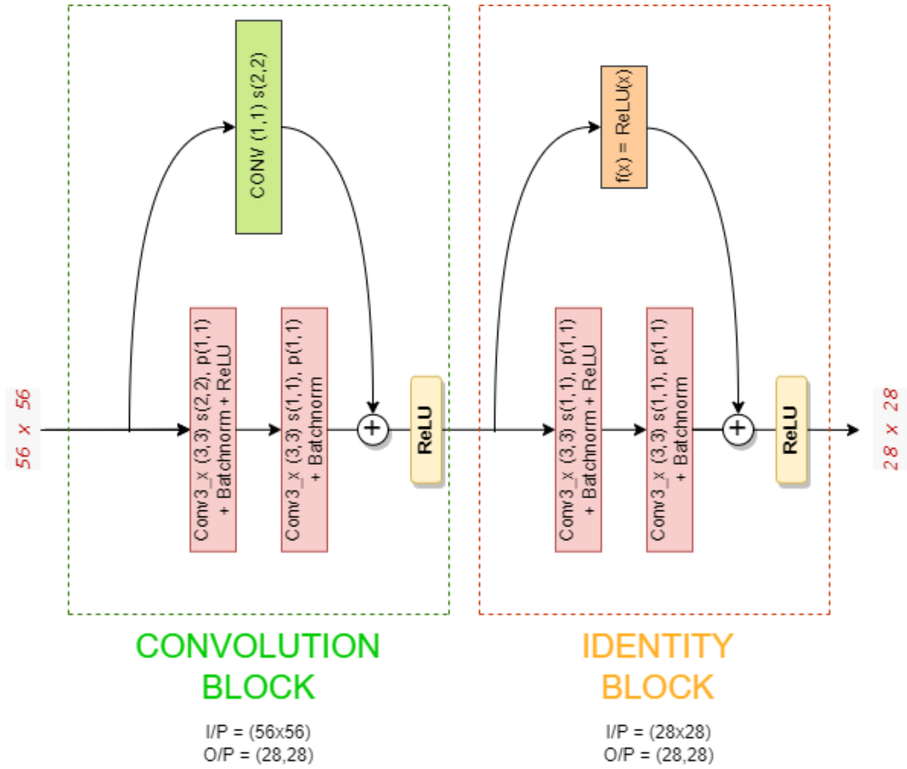
- A **MobileNet** model trained by google with **Tensorflow Lite**
- Detects the **key body points**
- We converted it to **PyTorch** format
- We **finetuned** it with custom upper-body data for **improved accuracy**



# Analysation – V.1 ResNet

Version 1 (ResNet)

- A custom **ResNet** architecture **Convolutional Neural Network (CNN)**
- Trained on **custom-made data**
- Takes the output of PoseNet and detect whether the user is sitting correctly or not



# Analysation – V.1 Problems

Version 1 (ResNet)

- Even lightweight CNN introduce **latency**
- Cannot be processed by ordinary devices
- FPS dropped to ~3

```
Average FPS:  2.7269552570218814
```

# Analysation – V.2 Geometry

Version 2 (Geometry-based heuristics)

- **Mathematical** approach to calculate roll and pitch angles
- Reduce **computational requirements**
- Makes PosturePal **accessible**
- FPS increases to around 30

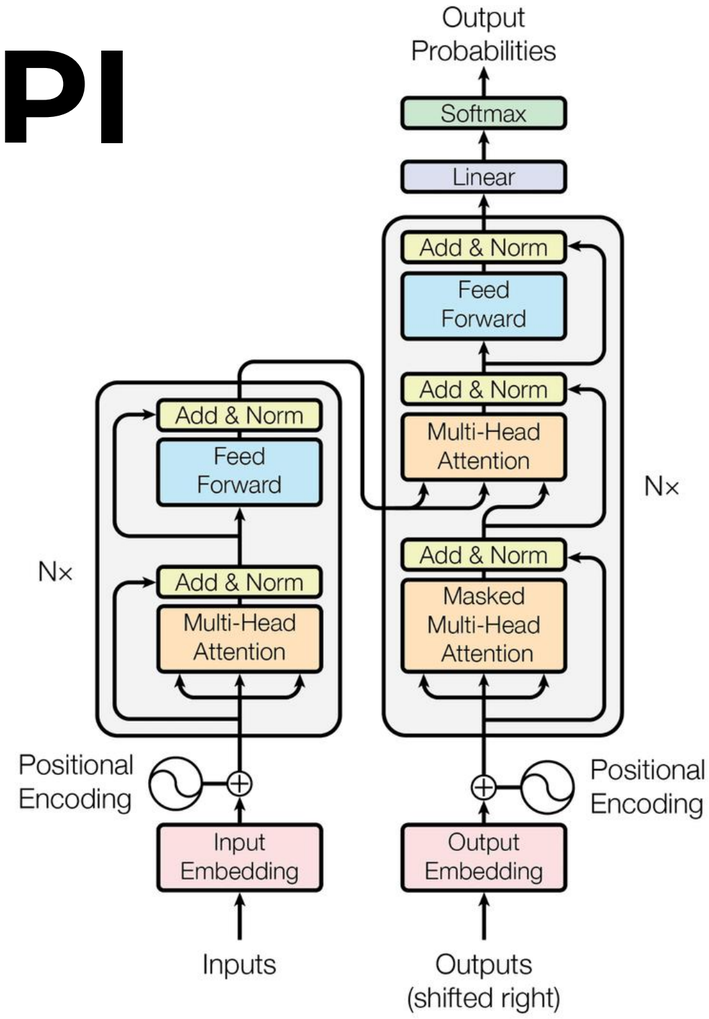
```
eye_vector = right_eye - left_eye

roll = np.arctan2(eye_vector[1], eye_vector[0]) * (180 / np.pi)

if roll > 180:
    roll -= 360
roll += 90

shoulder_mid = (left_shoulder + right_shoulder) / 2
eye_mid = (left_eye + right_eye) / 2
mid_vector = eye_mid - shoulder_mid
pitch = np.arctan2(mid_vector[1], mid_vector[0]) * (180 / np.pi) - roll

pitch = -pitch
pitch += 180
if pitch > 180:
    pitch -= 360
pitch += self.height / 30
```

```
Average FPS:  27.073086818040377
```

# OpenAI LLM (GPT-4) API

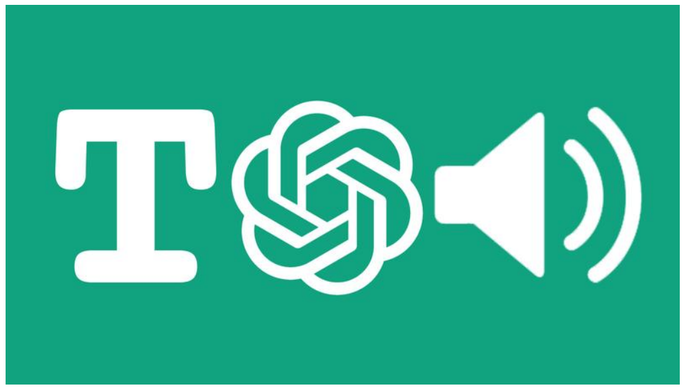
- Users are asked what their interests are
- Generates **fun, relatable and personalised** text
- Improves **user experience**

GPT - 4



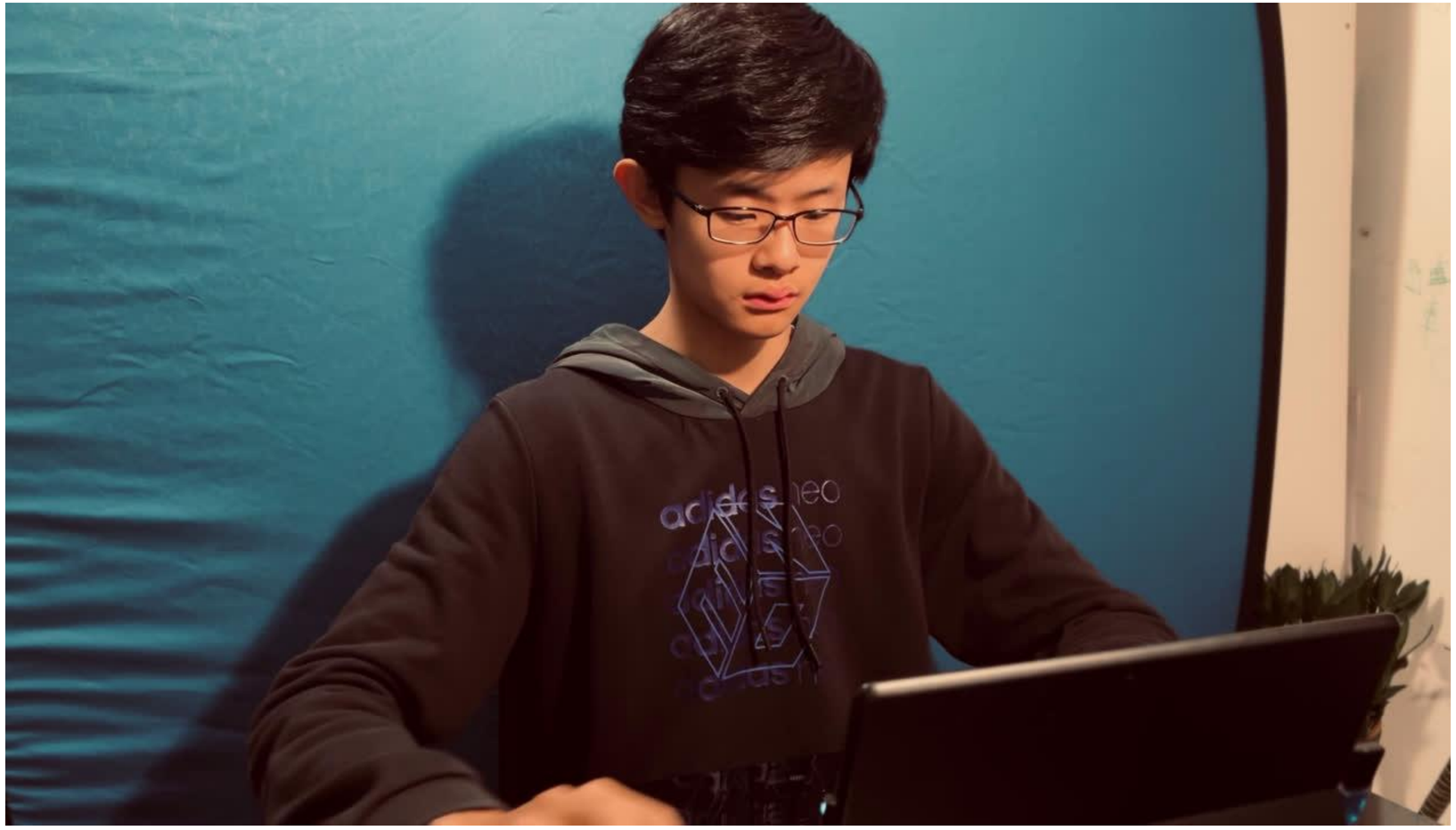
# OpenAI Text-to-Speech API

- Reads out the generated texts by the LLM
- An “Audio User Interface”
- Users can choose between 6 different voices
- Gives the user a **friendly & nice feel**

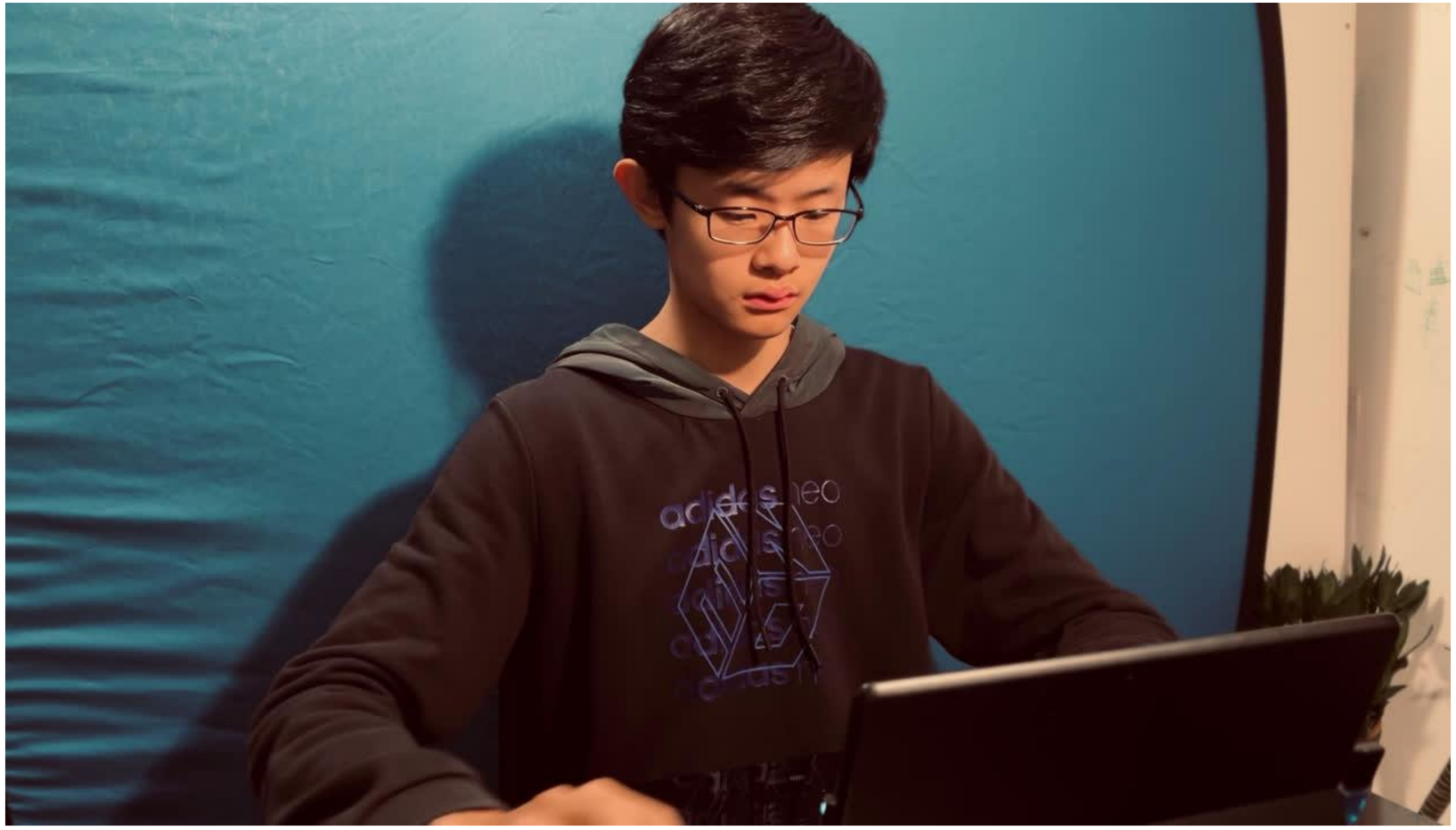


# Prototype Demostration

# Good Sitting Posture

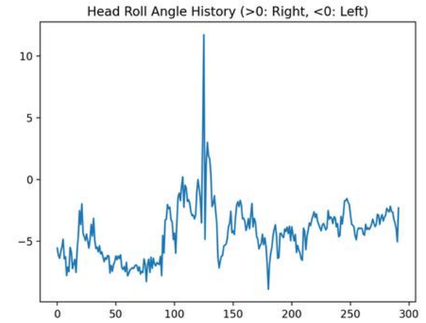


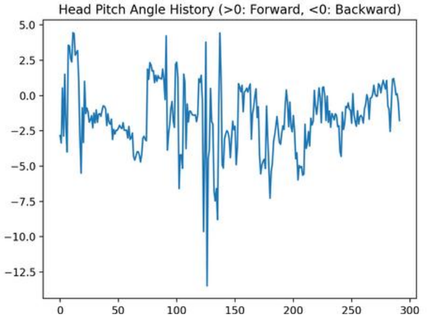
# Bad Sitting Posture



# Prototype Testing

- We invited some of our schoolmates to test our prototype
- Our prototype received an average score of **8.6/10**
- Most of them **liked our system & think it can help them** to correct their sitting postures



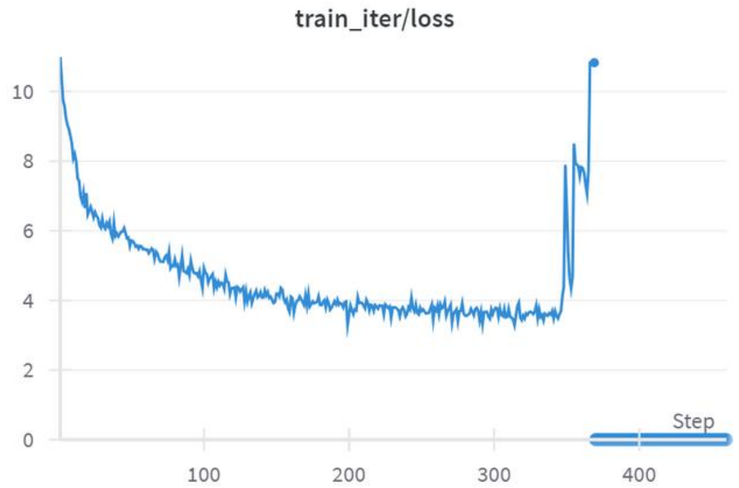




# Difficulties & Challenges

- Real-time processing and analysis latency
- **Suboptimal hyperparameters** for training and finetuning
- Custom ResNet model **overfitting**
- Dynamic & fun LLM response generation

```
Traceback (most recent call last):
  File "C:\Users\eason\OneDrive - La Salle College\vs_code_2022\AI\PosturePal\run.py", line 221, in <module>
    main()
  File "C:\Users\eason\OneDrive - La Salle College\vs_code_2022\AI\PosturePal\run.py", line 174, in main
    roll, pitch = resnet(input_image, keypoint_coord)
  File "C:\Users\eason\AppData\Local\Programs\Python\Python39\lib\site-packages\torch\nn\modules\module.py", line 1511,
in _wrapped_call_impl
    return self._call_impl(*args, **kwargs)
  File "C:\Users\eason\AppData\Local\Programs\Python\Python39\lib\site-packages\torch\nn\modules\module.py", line 1520,
in _call_impl
    return forward_call(*args, **kwargs)
  File "C:\Users\eason\OneDrive - La Salle College\vs_code_2022\AI\PosturePal\posenet\resnet.py", line 35, in forward
    roll, pitch = self.model(image)
  File "C:\Users\eason\OneDrive - La Salle College\vs_code_2022\AI\PosturePal\posenet\resnet.py", line 30, in model
    pitch_angle = image[1].max()
IndexError: index 1 is out of bounds for dimension 0 with size 1
```

```
Average FPS:  2.7269552570218814
```



# Future Works

- Improve the accuracy of sitting posture detection with **MoveNet** (Goyal et. al., 2023) or even based on **pressure distribution** (Seo et. al., 2021)
- **Decrease the computational complexity** for running on low-spec laptops / tablets 💻
- Release to the public for more feedbacks to improve the system
- More advanced feedback systems, e.g. mini games, better jokes 🤣



**MoveEnet: Online High-Frequency Human Pose Estimation with an Event Camera**

Gaurvi Goyal, Franco Di Pietro, Nicolo Carissimi, Arren Glover, Chiara Bartolozzi
*Event-Driven Perception for Robotics*
Istituto Italiano di Tecnologia, Italy
{gaurvi.goyal, franco.dipietro, nicolo.carissimi, arren.glover, chiara.bartolozzi}@iit.it

**Abstract**

*Human Pose Estimation (HPE) is crucial as a building block for tasks that are based on the accurate understanding of human position, pose and movements. Therefore, accuracy and efficiency in this block echo throughout a system, making it important to find efficient methods, that run at fast rates for online applications. The state of the art for mainstream sensors has made considerable advances, but event camera based HPE is still in its infancy. Event cameras boast high rates of data capture in a compact data structure, with advantages like high dynamic range and low power consumption. In this work, we present a system for a high frequency estimation of 2D, single-person Human Pose with event cameras. We provide an online system, that*

Figure 1. Sample result of MoveEnet from the event-Human 3.6m dataset superimposed on EROS representation

cameras has increased in the recent years, as they deliver information in a more compact data format, thus,

Implementation of CNN Model for Classification of User Sitting Posture Based on Pressure Distribution

Ji-Yun Seo, Ji-Su Lee, Sang-Joong Jung, Yun-Hong Noh & Do-Un Jeong

Conference paper | First Online: 06 February 2021

**1076** Accesses

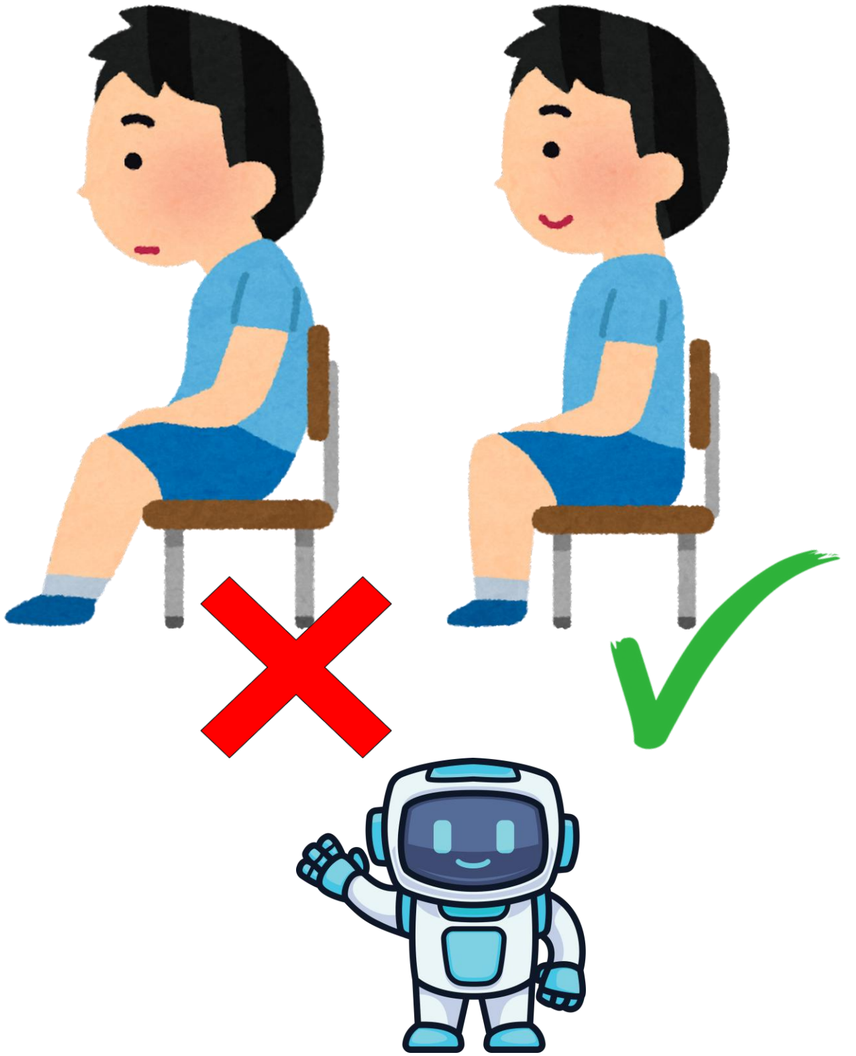
Part of the Lecture Notes in Computer Science book series (LNISA,volume 12616)

Abstract

Musculoskeletal disease is often caused by sitting down for long period's time or by bad posture habits. In order to prevent musculoskeletal disease in daily life, it is the most important to correct the bad sitting posture to the right one through real-time monitoring. In this study, to detect the sitting information of user's without any constraints, we propose

# Conclusion

- Solve the problem of **incorrect sitting posture** with a **fun & personalized** approach
- Utilizes **LLMs** for **engaging, interactive feedback** on posture
- Tailors feedback to resonate with individual **user interests** and **humor**
- Innovates **human-machine communication** with fun, interactive reminders

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# Thank you