IIT GANDHINAGAR

JoulesEye: Smartwatch for Respiration Sensing Using Thermal Camera

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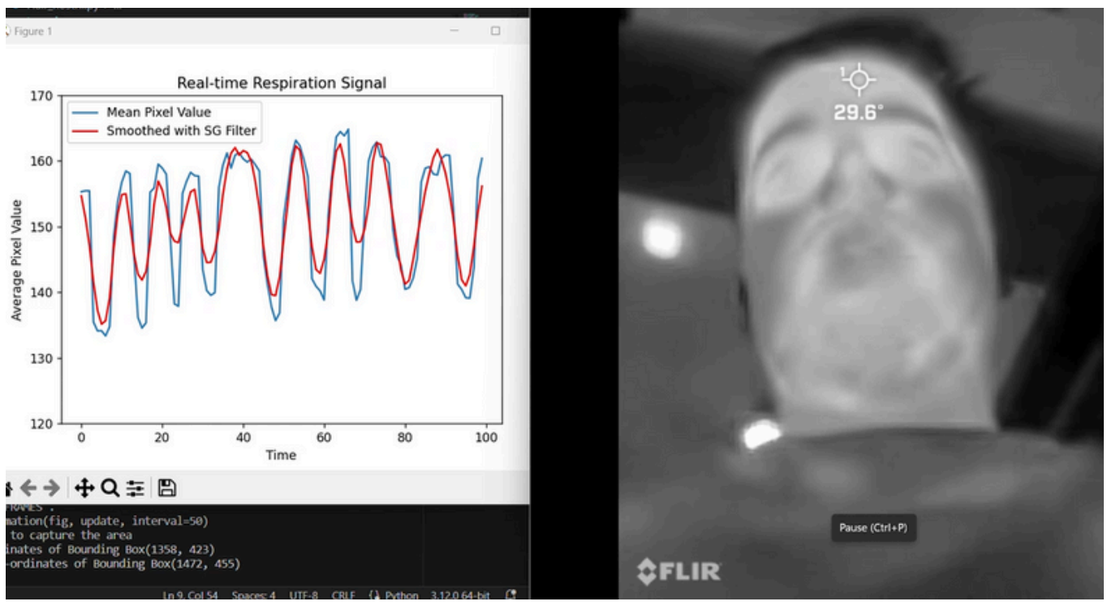
1. Introduction

JoulesEye is an innovative smartwatch prototype designed to monitor respiration signal using thermal imaging. It features a 32x24 pixel low-resolution thermal camera integrated with a microcontroller, capturing temperature variations around the user's nostrils to accurately detect breathing patterns.

Challenges:

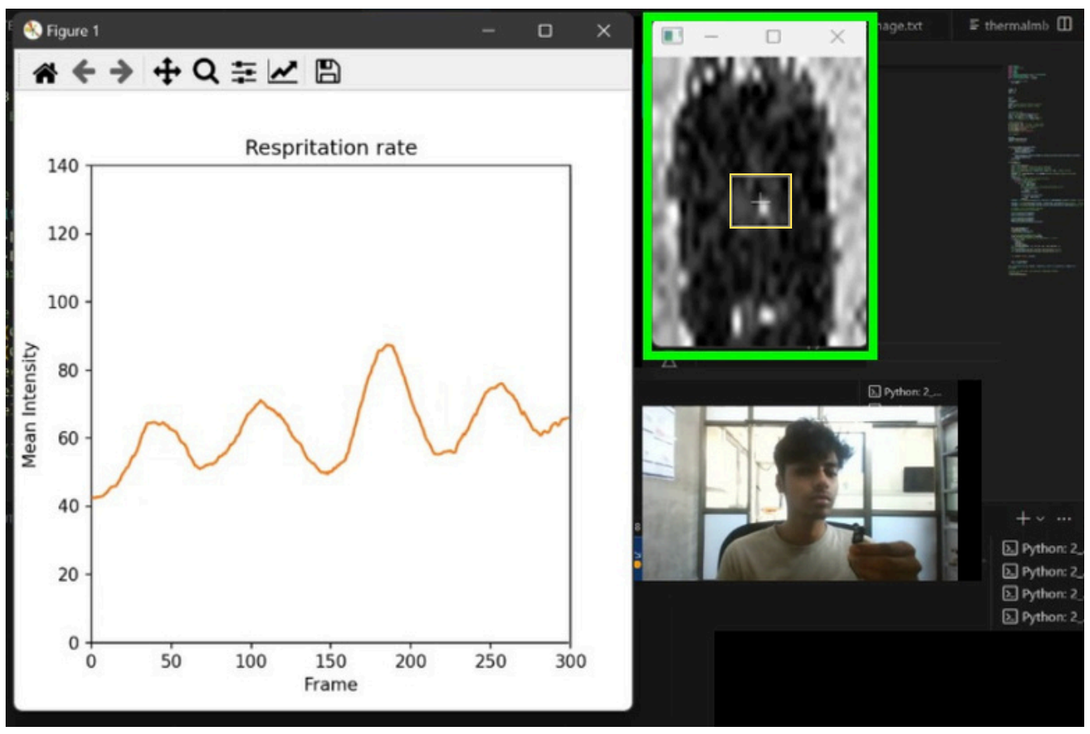
- Latency in real-time processing
- Low-resolution thermal camera
- Processing limitations

2. Concept Validation using High-Res



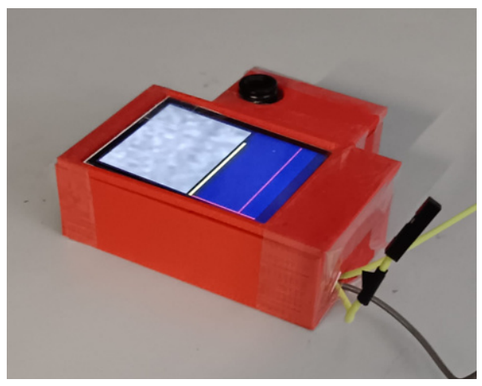
Demonstrated **respiration signal extraction** by utilizing a high-resolution camera to validate the underlying theoretical concepts.

3. Validation using Low-Res



- Capturing live feed of the user using a low-resolution thermal camera on laptop.
- Implementing **intercubic interpolation** to resize the video feed.
- Users **align their nostrils** within a designated area on the video feed.
- Smoothening the respiration signal in real-time using **convolution** techniques and displaying it on graphs.

4. Prototype using Low-Res



Scan this for Prototypes Demonstration

- Enhanced **portability** for easy mobility.
- **High frame rate** for capturing sudden movements.
- Algorithms enabling **real-time** signal processing.

Another prototype includes **real-time Bluetooth data logging** for further processing and analysis using **streamlit applicaiton.**

5. Results

- Prototype tested on 4 participants by syncing breathing to a metronome where **2 ticks equaled 1 breathing cycle**. Verified alignment by counting peaks in the respiration signal and comparing with the expected count from the metronome.

Particicpants	% Accuracy
1	94.28
2	90.47
3	96.29
4	92.3
Average Accuracy	**93.34**

Scan this for Results and concept validation

6. Limitations And Future Work

Limitation: Requires a controlled environment for accurate performance.
Futue work :Enhance hardware for better processing power to enable real-time nostril tracking.

Adhikary, Rishiraj, et al. "JoulesEye: Energy Expenditure Estimation and Respiration Sensing from Thermal Imagery While Exercising." Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies 7.4 (2024): 1-29.