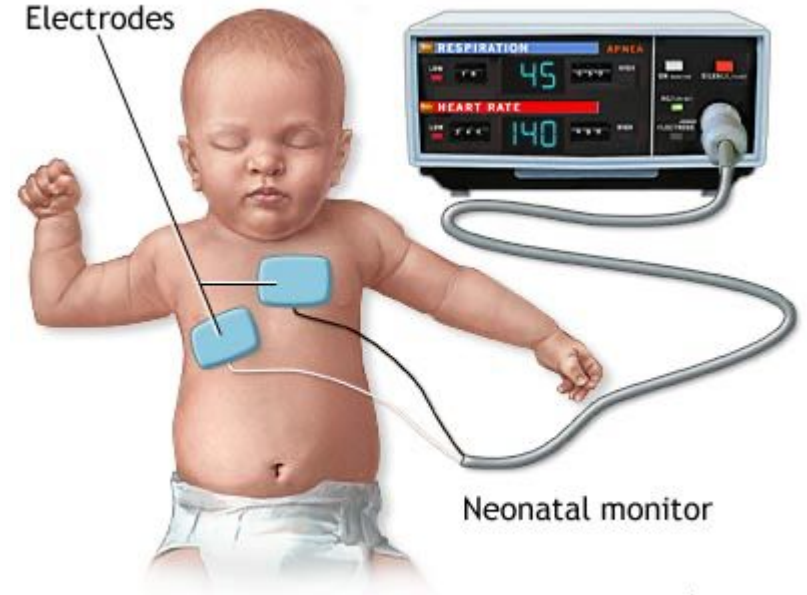


# Signal Quality and ROI Analysis for Video-Based Contactless RR Estimation

Haley Patel  
Mentor: Dr. Zahid Hasan

# Motivation

- Enhanced Patient Comfort & Reduced Infection Risk
- Long-Term Care Facilities
- Neonatal Intensive Care Units (NICU)
- Intensive Care Units (ICU)
- Telehealth & Remote Monitoring
- Sleep Studies & Sleep Apnea Patients
- Robustness to Distance Variation
- Accurate Region of Interest (ROI) Detection



# Data Collection

## In-house data collection

- 23 Videos, each 1 min long
- 5 subjects

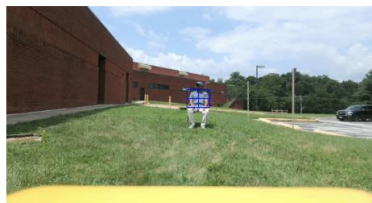
BREATHING PHASE INTERVALS FOR EACH VIDEO RECORDING.

| Video Interval (sec) | Breathing Phase  |
|----------------------|------------------|
| 0–20                 | Normal breathing |
| 20–40                | No breathing     |
| 40–60                | Forced breathing |

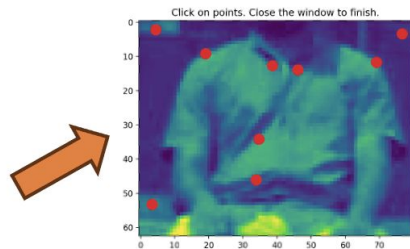
*Note: Forced breathing refers to deep inhalations and exhalations.*



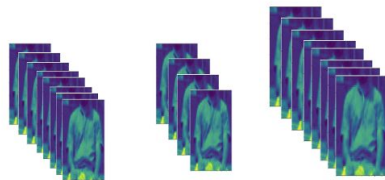
# Methodology



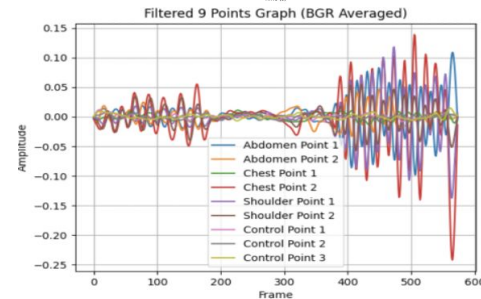
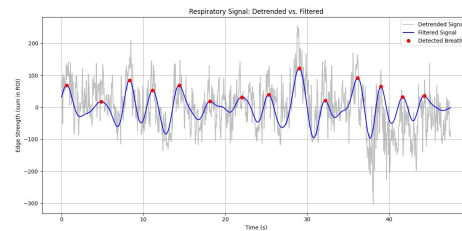
Manually select ROI



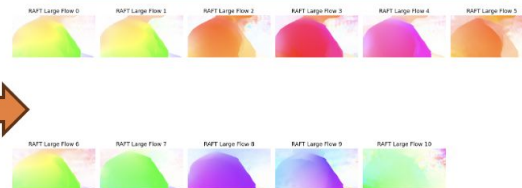
Manually select 6 torso and 3 control points



Take 10 normal breathing, 5 no breathing, 10 heavy breathing frame pairs

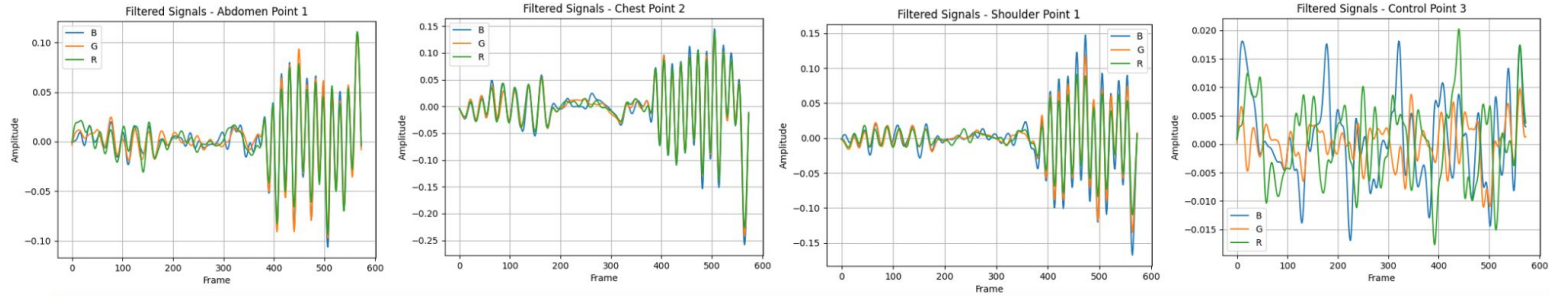


Apply Bandpass Filter and record Pixel Intensity over time

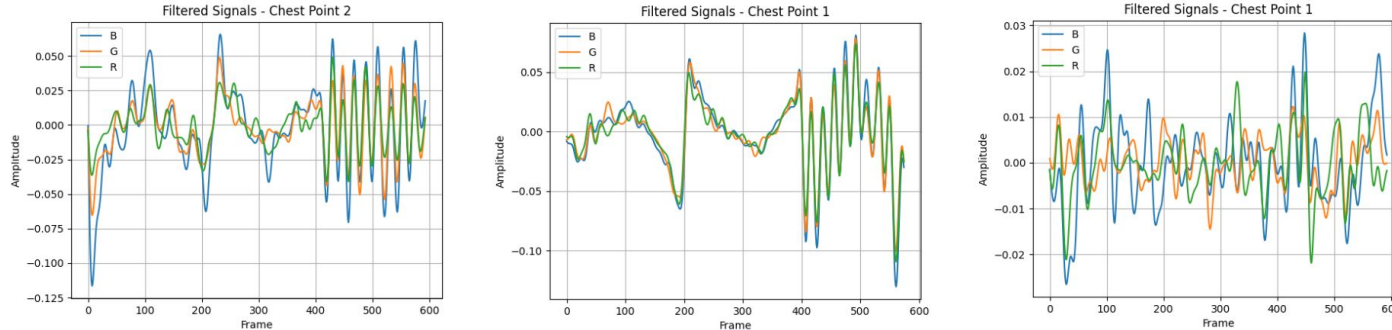


Run the frames through RAFT large and small model to generate flow field and record  $|v|$  and  $|\langle u, v \rangle|$  and record dominant ROI

# Qualitative Results



Pixel intensity over time for different points at a distance of 4m for subject m. Clear periodic and strong signals are observed in the chest, abdomen, and shoulder regions across B, G, and R channels, while the control point shows only noise.



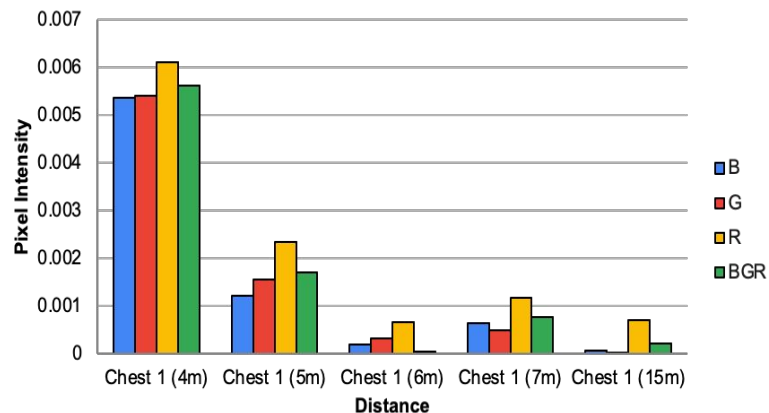
Pixel intensity signals from the Chest region at increasing distances (6m, 7m, 9m respectively) for subject m. As distance increases, the signal amplitude weakens and the signal-to-noise ratio decreases, indicating degraded visibility of respiratory motion.

# Qualitative Results

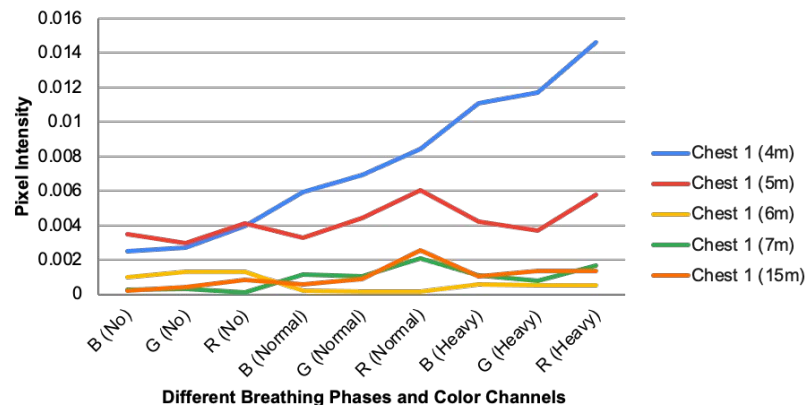
**Correlation Values Between Pixel Intensity and RAFT Optical Flow Magnitudes Across Breathing Phases and Anatomical Points**

| Model | Breathing Phase | Abdomen 1 | Abdomen 2 | Chest 1 | Chest 2 | Shoulder 1 | Shoulder 2 | Control 1 | Control 2 | Control 3 |
|-------|-----------------|-----------|-----------|---------|---------|------------|------------|-----------|-----------|-----------|
| Large | Normal          | 0.1093    | 0.0148    | 0.1785  | 0.2369  | 0.0907     | 0.2775     | -0.2018   | -0.2714   | -0.0960   |
| Small | Normal          | 0.0682    | 0.0787    | 0.3901  | 0.1172  | -0.0615    | 0.0438     | -0.2786   | -0.0998   | -0.1540   |
| Large | Heavy           | 0.5999    | 0.1367    | 0.5934  | 0.7206  | 0.5088     | 0.4254     | -0.0085   | 0.5014    | 0.1210    |
| Small | Heavy           | 0.3948    | 0.1277    | 0.8057  | 0.5627  | 0.4171     | 0.3993     | 0.1905    | 0.3901    | 0.0658    |

**Average Pixel Intensity of each Color Channels Over Distance**



**Pixel Intensity Strength over different Breathing Phases**



# About the Experience

## Skills Learned:

- **Computer Vision:** hands-on experience with **computer vision techniques**, including using the **OpenCV library** for various functions like **edge detection** and **preparing image data** for models.
- **Data Management:** proficient in **annotating video data** and understand critical concepts such as **sampling rate and interval rules**.
- **Automation:** learned to use **Python scripts** to automate repetitive tasks, such as generating file lists and **converting video formats**.
- **Scientific Communication:** practiced key skills in **scientific communication**, including creating a **research poster**, writing a **research paper**, giving **presentation**, and the important practice of **documentation**.
- **Algorithmic Comparison:** experience **comparing and analyzing different optical flow algorithms**, from older methods like **Lucas-Kanade** to more modern ones like **RAFT**.

# About the Experience

## Challenges:

Time Constraint:

- Access to GPU on Week 6
- Data Collection on Week 7

Failed Feature Implementations

## Addressing the Challenges:

- Identifying the Core Research Question
- Focus on Minimum Viable Product
- Scope Down the Project
- Propose Future Work
- Consult with Mentor

# About the Experience

