Eulerian Video Magnification Respiratory Monitor

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Problem Description

High or low respiratory rates in babies can indicate an oxygen-deficiency or infant sleep apnea, among other conditions. Even so, baby monitors on the market are lacking the ability to measure respiratory rate as a vital sign. For anxious parents looking to monitor respiratory rate, the current technology is prone to false alarms and/or interferes physically during sleep.

Background

- There are few baby monitoring systems that remotely and accurately capture data
- In 2012, MIT released open source software via MATLAB called Eulerian Video Magnification which magnifies small movements
- The most common way to measure respiratory rate is by counting the rise and falls of the rib cage
- A healthy baby has a respiratory rate between 30 and 60 breaths/minute

Objectives

- Accurately monitor the respiratory rate of an infant
- Make breathing motions as clear as possible on the monitor
- Allow the infant to sleep undisturbed during surveillance
- Reduce parental anxiety

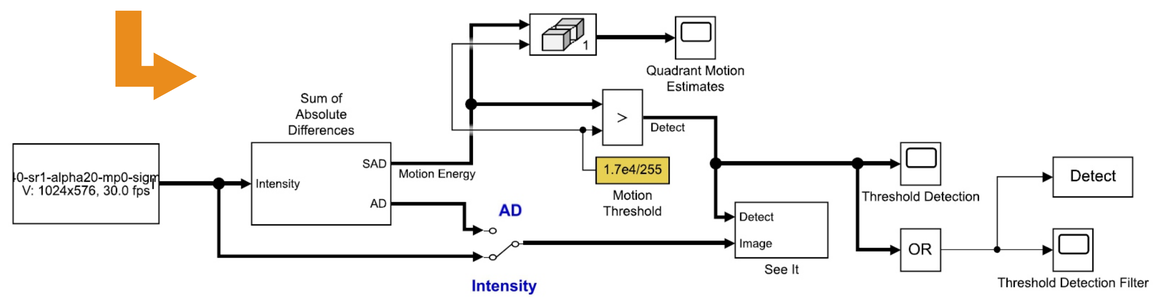
Proposed Design

The proposed design uses Eulerian Video Magnification to exaggerate the motions of a rib cage associated with breathing.

Key Components:

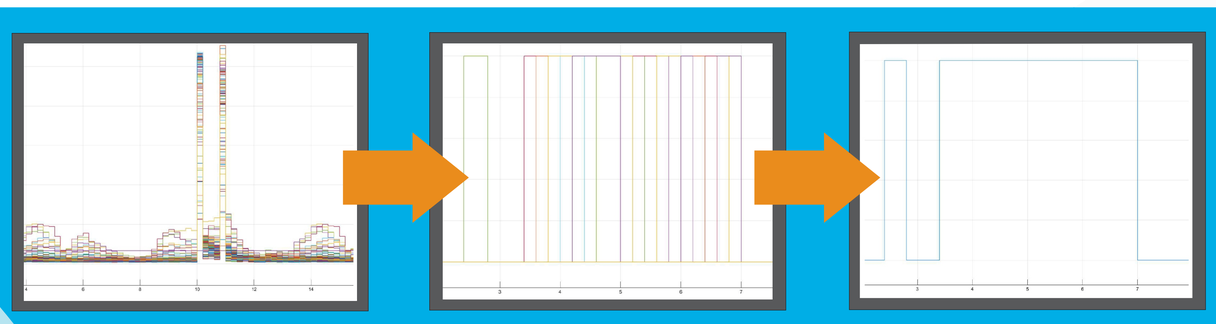
1. **Raspberry Pi and Pi Camera for video capture**
   - 10s video clips captured 2x/min
2. **MATLAB sourcecode**
   - frame rate adjusted to 4 FPS to optimize processing time
3. **Motion Detection using Simulink**
   - magnified motion is detected by changes in pixel region

Simulink Model for Motion Detection

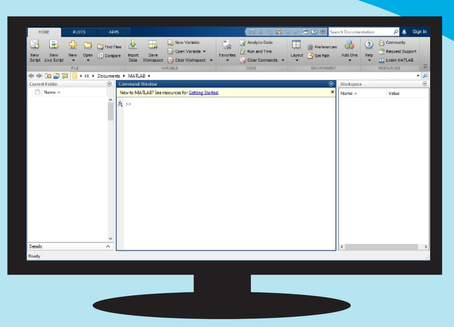


Testing & Validation

The following graphs were obtained from segments of a magnified video clip. From the filtered motion, the respiratory rate can be accurately extracted.

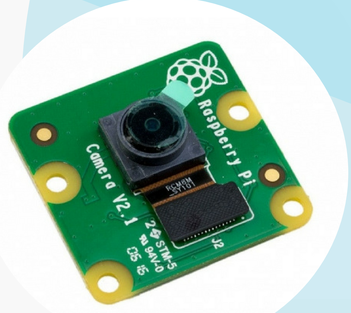


ALL DETECTED MOTION | ALL MOTION ABOVE THRESHOLD | FILTERED MOTION

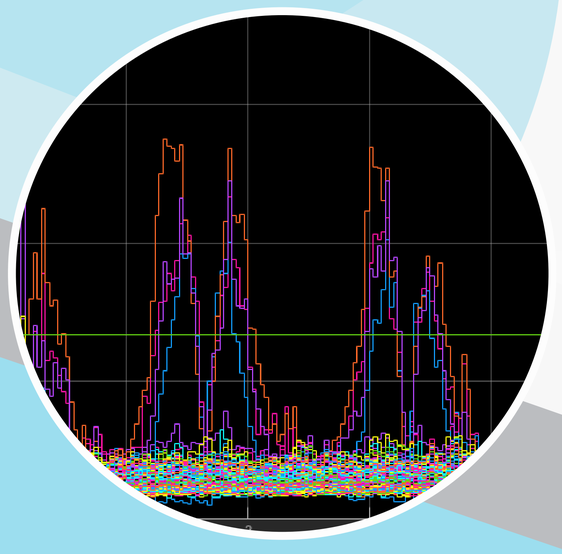


Record and send video to PC

Magnify video and detect motion



Capture respiratory rate from filtered waveforms



Conclusions

- The baby monitoring system makes tracking respiratory rate clearer for caretakers
- This system is a viable option for parents/caretakers on a budget
- Live video feed was found to be unnecessary to capture the required data
- According to Nyquist theorem, frame rate can be as low as 4 fps while still capturing a respiratory rate up to 120 breaths/minute
- The software still has room for improvement concerning processing time

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