Using (PVDF) Sensors and Microphones To Determine Infant Heart Rate and Respirations in Novel Machine Learning Modeling Approach to SIDS Detection

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Sudden Infant Death Syndrome (SIDS), the leading cause of death for toddlers and infants with 15,000 annual deaths, occurs for unknown reasons while sleeping, however is detectable through bradycardia, hypoxia, and apnea prior to death. In this project, a mattress is developed that can comfortably, accurately, and cost effectively output infant heart rate (HR) and respiration rate (RR) to detect SIDS. 4 Polyvinylidene Fluoride (PVDF) sensors embedded in a rhombus formation detect S1/S2 vibrations in the body. 2 Microphones collect audible inhale/exhale sounds and surrounding noise. An Arduino Nano collection system sends recorded data serially to the Raspberry Pi processing unit. Fast Fourier Transforms (FFT) on PVDF data detect specific frequencies and a simulation approach ranks possible results with the fitness function to determine HR correlating to calibrated values. Microphone data is actively noise cancelled and FFTs create a sinusoidal plot of frequency weighted averages to determine RR and frequency of breaths. Outliers from a One Class Classification Model Support Vector Machine of the infant's sleeping patterns with 85% specificity are inputted to a Recurrent Neural Network Gated Recurrent Unit supervisially trained on 192 datapoints and tested with SIDS memory recordings and simulated normal values yielding 100% detection 3 minutes prior to SIDS and no false positives. A SIDS event alerts parents with a mobile app displaying HR and RR for monitoring. Mattress testing on 3 infants less than 6 months with corresponding real physiological data yields a mean HR accuracy of 99.7% and mean RR accuracy of 94.5%. The mattress developed can cost effectively and comfortably report accurate infant physiological parameters using custom machine learning to detect SIDS.