

Archotyping artifacts in monitored noninvasive vital signs data

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Introduction:

False alerts in monitored patients cause alarm fatigue in clinical staff and can adversely impact medical outcomes. We used an informative clustering approach (Fiterau, Dubrawski: A Unified View of Informative Projection Retrieval, ICMLA 2013) to identify human interpretable archetypes of false alerts as a preliminary step to corrective action plans.

Methods:

Noninvasive vital signs (VS) data including ECG-derived heart rate (HR), respiratory rate (RR), systolic and diastolic blood pressure (BP), and peripheral oximetry (SpO2) collected at 1/20Hz frequency contained 1582 physiological abnormality episodes (HR140, RR36, systolic BP 200, diastolic BP>110, SpO2<85%). A committee of 4 expert clinicians adjudicated them as 1115 real alerts, 318 artifacts, 149 unclear. Statistical features extracted from periods of 4 min before each event: mean, std dev (sd), min, max, data duty cycle (DD), min and max of 1st order differences, gradient, etc. were used to cluster artifacts triggered by exceedences in specific vitals: RR (111), SPO2 (137), BP (70) in low-d projections for easy interpretation.

Results:

Clinician review of the patterns elicited the following opinions. A cluster of RR artifacts on features RR mean [0,4] and RR sd [2,5] likely suggests a loose ECG lead, while a pattern RR mean [33,40] and RR sd [0,10] is likely due to insufficient bioimpedance. For SpO2 artifacts, features SPO2 min and SPO2 slope expose patterns suggesting motion, sensor reattachment and loose lead or low perfusion. The patterns identified for RR artifacts (HR-DD \sim 0, SPO2-DD bimodal with peaks at 0.1 and 0.01) suggest the lack of ECG electrode integrity. For SPO2, decreases in both HR-DD and RR-DD appear associated with artifact and suggest an overall problem with signal pickup in both SPO2 and the ECG/RR sensors.

Conclusions:

Informative clustering techniques support automated interpretation of artifacts identified in VS monitor data streams. Identified artifact archetypes agree with clinical intuition and can potentially be used to guide corrective actions in practice.

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