A Vision-Based Method for Non-Invasive Respiration Rate Monitoring

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Abstract: There are four vital signs that are monitored by medical professionals: pulse rate, respiration rate, body temperature, and blood pressure. Currently, there are widely used commercial medical devices for three of these four vital signs: a thermometer is used to measure body temperature, a pulse oximeter is used to measure pulse rate, and a BP monitor is used to measure blood pressure. However, there is no commercial medical instrument used by medical professionals to measure respiration rate. The current archaic method of measuring respiration rate, a nurse manually observing breathing rate with a stopwatch, is prone to human error and expends unnecessary time and efforts of medical personnel. The baseline accuracy for respiration rate is within four breaths per minute of the true respiration rate 78% of the time. Respiration rate is an important vital sign that could be used to indicate the health of an individual and predict an array of diseases (i.e. diabetes, asthma, lung disease, COVID-19, etc). However, it remains the least measured vital sign because of the intrusiveness of most adopted sensors. Developing an economical, non-invasive, and accurate medical device that measures respiration rate is an important solution to analyze a patient's overall health. We present a non-invasive computer vision based system for monitoring respiration rate by observing abdominal expansion and contraction as a person inhales and exhales. First, we use dense pyramid Lucas-Kanade optical flow to calculate the translation between breath movement for sequential frames in webcam video of a patient lying face up in frame. Then, we perform median filtering and use local peak detection to count the number of breaths taken over a dynamic, user-determined time frame. Our pipeline and rich feature extraction provides an optimal means for developing a transformer language model to learn normal breathing patterns and identify irregularities in peaks. We evaluate on a dataset of graphs of translation of optical flow throughout the duration of monitoring. Through anecdotal evidence amongst five individuals who have tested our system, our system achieves a 90% accuracy rate against a baseline of self-monitored respiration rate.

Index Terms: image analysis, respiration rate, optical flow, personalized healthcare