A Novel Approach for Automatic Visualization and Activation Detection of Evoked Potentials Induced by Epidural Spinal Cord Stimulation in Individuals with Spinal Cord Injury

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**S2 Appendix. Pseudocodes of All Algorithms in the Framework**

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| **Algorithm I:** 2-D representation of the raw EMG signals |
| * Find the time intervals between each two consecutive stimulation pulsations using the onset timing of each stimulation * Use the time intervals to segment the EMG signals into corresponding pieces * Repeat for all the muscles * Save the samples of EMG segments into a matrix where *m* is the number of stimulation pulsation, *n* is the maximum time interval between consecutive stimulations, and *l* is the number of muscles. * Use *imagesc* function to visualize each matrix as Colormap image * Repeat for all muscles |

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| **Algorithm II:** Noise reduction |
| * Initialize the GGMRF parameters , , , , and for Eq. 2.1 * Determine the window size for the Eq. 2.1 * Design an all ones mask matrix and set its four borders rows and columns to zero * Use segmentation matrix, mask matrix, parameters and window size to substitute in Eq. 2.1 and calculate the estimated value for the pixel * Repeat for all pixels * Repeat for all muscles |

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| **Algorithm III:** Activation detection using SOD method |
| * Select the background noise as the first non-zero segment of the de-noised EMG signal * Use *mle* function to estimate the Gaussian distribution parameters and * For each segment of the de-noised signal use *mle* function to estimate the Gaussian distribution parameters and * Calculate using Eq. 2.4 for all segments *i* of the de-noised signal * Select the baseline as the first event of the de-noised EMG signal * Calculate and for the selected baseline to find the activation threshold *h* using Eq. 2.5 * Compare each with *h*: **If** , detect the evoked potential in the segment and represent it with 1, **else** there is no evoked potential and represent it with 0 * **If** 50% of the segments inside one *event* is active call the whole *event* active, **else** call it inactive * Repeat for all *events* * Find the corresponding stimulation intensity to the first active *event* and assign it as the voltage threshold * Repeat for all muscles |

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| **Algorithm IV:** Feature extraction |
| **Peak-to-peak and min-max interval:**   * Divide each segment into 8 pieces and find the maximum and minimum amplitude values inside the first piece and their corresponding timings and . * Calculate the peak-to-peak value () and min-max interval () for each segment * Repeat for all segments * Take the average over all and values inside one *event* * Repeat for all *events* * Repeat for all muscles   **Activation latency:**   * Up-sampling the signal to 100,000 samples per second using function interp1. * Divide each segment, which are detected as active by Algorithm III, into 20 pieces and take the first five pieces as baseline * Apply the same method in Algorithm III to detect the onset timing of the evoked potential in each segment * Repeat for all segments * Take the average over all inside one *event* * Repeat for all *events* * Repeat for all muscles   **Integrated EMG:**   * Rectify each segment of the EMG signal * Take the integral of the rectified signal * Repeat for all segments * Take the average over all values inside one *event* * Repeat for all *events* * Repeat for all muscles |

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| **Algorithm V:** Visualization |
| * Use *csaps* function (cubic smoothing spline) to interpolate the missing values for , and * Assign each feature values to the corresponding stimulation intensity voltage * Repeat for all *events* * Repeat for all the muscles * Use *imagesc* function to visualize each matrix as Colormap image |

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| **Algorithm VI:** Activation detection using TKEO method |
| * Segment the signal based on stimulation timings (similar to Algorithm I) * Calculate the TEKO value for each sample inside the segment * Repeat for all segments * Repeat for all muscles * Take the first *event* after TKEO operation as baseline * Calculate the baseline maximum and standard deviation and find the activation threshold * Calculate the maximum value for the segment * **If** , detect the evoked potential in the current segment and represent it with 1, **else** there is no evoked potential and represent it with 0 * Repeat for all segments * **If** 50% of the segments inside one *event* is active call the whole *event* active, **else** call it inactive * Repeat for all *events* * Find the corresponding stimulation intensity to the first active *event* and assign it to be the activation intensity threshold * Repeat for all the muscles |