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Highly sensitive estimation of significant SCR for wrist-worn electrodermal activity

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Abstract— **We proposed a method to utilize EDA from wrist to counter its lack of sensitivity in estimating significant SCR. Comparing the estimated time of SCR at the transition from baseline to task, a delay between EDA from wrist and finger were confirmed with correlation to slope of SCL. Adaptive thresholding that controls threshold of discriminating SCR by the value of past slope of SCL showed ability to estimate transition with high sensitivity.**

I. INTRODUCTION

The electrodermal activity (EDA) from wrist is expected to realize daily life monitoring with less stress as an index of sympathetic activity. Though, the lack of sensitivity compared to EDA from finger is also known [1], details of this issue are not confirmed. We focused on the time delay of the rise of phasic components of EDA (skin conductance response: SCR) at wrist when transition from baseline to task state occurs. We tackled this delay by accounting for tonic components of EDA (skin conductance level: SCL) before the transition and validated a method to shorten the delay of estimated transition.

II. METHODS

Time series of EDA from finger and wrist were collected from healthy participants (39 trials) conducting 7 minutes baseline followed by 5 minutes of cognitive task which was expected to increase SCRs. 14 trials were selected by good EDA signal quality for both locations. Most trials not selected were due to artifacts and very low EDA from wrist.

SCRs were derived by Ledalab 3.4.7[2]. Following previous studies, SCRs from wrist were extracted with the threshold of 0.05uS to distinguish significant SCRs. The estimated transition point from baseline to task were defined by the estimation of corresponding significant SCR for each measured location. The time gap of the estimated transition points by measured location were used for following analysis.

The relationship between the time gap of the estimated transition points and slope of SCL from wrist during 60s before the estimated transition point was evaluated. Then we analyzed a proposing thresholding method to adaptively change thresholds of SCR to a lower value than 0.05uS while slope of SCL is below 0. The difference of conventional method and proposed method to estimate transition point was compared by the time gap of the estimated SCR.

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III. RESULTS & CONCLUSION

Fig.1 is an example of EDA at wrist and finger, (A) shows the raw EDA and (B) shows the delay of EDA from wrist in estimating SCR at transition. Fig.2 is the analysis of the proposed thresholding method. Interestingly, as shown in (C), when slope of SCL from wrist is below 0, the estimation sensitivity of SCR decreases. (D) indicates the proposed adaptive thresholding method estimates SCR at transition faster and more robustly than the conventional method.

We improved the sensitivity to estimate SCR of EDA from wrist by only using its' past features, which would lead to expanding the usability of wrist-worn EDA.

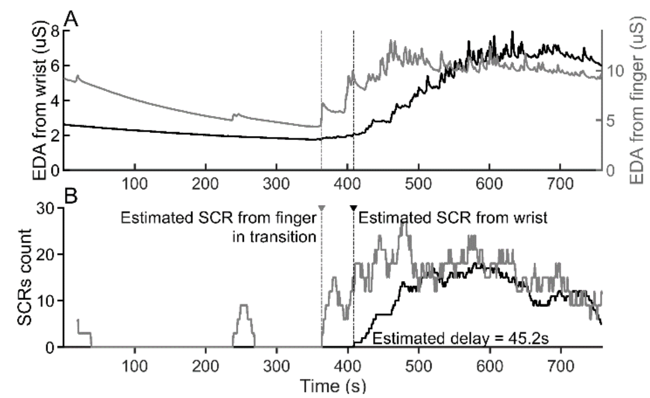

Figure 1. (A) Example of EDA from wrist (dark) and finger (light). (B) Number of SCRs counted in 20s window.

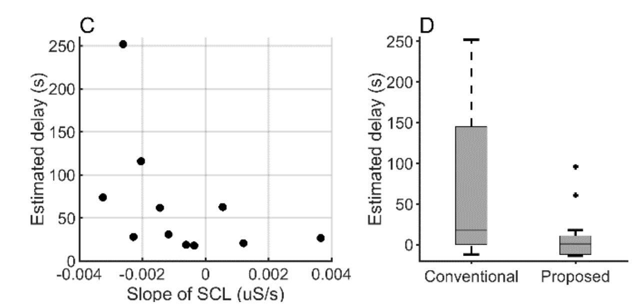

Figure 2. (C) Relationship of slope of SCL from wrist and estimated delay. (D) Delay of estimated transition point for 14 trials by thresholding methods.

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