UNIVERSITY OF SOUTH FLORIDA

Defense of a Doctoral Dissertation

Generative Spatio-Temporal and Multimodal Analysis of Neonatal Pain

by

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For the Ph.D. degree in Computer Science and Engineering

This dissertation focuses on developing an automated neonatal monitoring system that can replace the current manual system in a clinical environment. We explore the availability of current neonatal pain datasets and the challenges of neonatal pain data collection. We further collect and present a multimodal neonatal pain dataset, especially focusing on postoperative pain that mimics a real clinical environment. To develop the automated system, at first, we explore the effectiveness of individual modalities (i.e., facial expression, body movement, crying sound, vital signs) and propose novel spatio-temporal methods to analyze neonatal pain. Later, we develop a full multimodal system that is capable of using all modalities together to provide the pain signal. We also want to make sure that the automated system can effectively function in a real clinical environment. In a real clinical system, missing modality is very common due to different clinical factors (i.e., masked face, covered body, etc.) or algorithms' limitations (i.e., low light condition, side face view, etc.). We propose a multimodal system that can effectively regenerate pseudo-features for missing modalities and continue assessing neonatal pain.

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Publications

1) **M. S. Salekin**, G. Zamzmi, D. Goldgof, P. R. Mouton, K. J. S. Anand, T. Ashmeade, S. Prescott, Y. Huang, and Y. Sun, "Attentional generative multimodal network for neonatal postoperative pain estimation", in International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI), Singapore, Sep 2022.
2) **M. S. Salekin**, P. R. Mouton, G. Zamzmi, R. Patel, D. Goldgof, M. Kneusel, S. L. Elkins, E. Murray, M. E. Coughlin, D. Maguire, T. Ho, and Y. Sun, "Future roles of artificial intelligence in early pain management of newborns," Paediatric and Neonatal Pain, 2021.
3) Hausmann J, **M. S. Salekin**, G. Zamzmi, D. Goldgof, Y. Sun, "Robust neonatal face detection in real-world clinical settings," in Computer Vision and Pattern Recognition (CVPR) Workshops, Virtual, Jun 2021.
4) **M. S. Salekin**, G. Zamzmi, J. Hausmann, D. Goldgof, R. Kasturi, M. Kneusel, T. Ashmeade, T. Ho, and Y. Sun, "Multimodal neonatal procedural and postoperative pain dataset," Data in Brief, 2021.
5) S. S. Sribhashyam, **M. S. Salekin**, D. Goldgof, G. Zamzmi, M. Last, and Y. Sun, "Pattern recognition in vital signs using spectrograms," in IEEE International Conference on Systems, Man and Cybernetics (SMC), Australia, Oct 2021.
6) **M. S. Salekin**, G. Zamzmi, D. Goldgof, R. Kasturi, T. Ho, and Y. Sun, "First investigation into the use of deep learning for continuous assessment of neonatal postoperative pain," in IEEE International Conference on Automatic Face and Gesture Recognition (FG), Argentina, Nov 2020.
7) **M. S. Salekin**, G. Zamzmi, D. Goldgof, R. Kasturi, T. Ho, and Y. Sun, "Multimodal spatio-temporal deep learning approach for neonatal postoperative pain assessment," Computers in Biology and Medicine, 2021.
8) **M. S. Salekin**, G. Zamzmi, R. Paul, D. Goldgof, R. Kasturi, T. Ho, and Y. Sun, "Harnessing the power of deep learning methods in healthcare: neonatal pain assessment from crying sound," in IEEE Healthcare Innovations and Point of Care Technologies, (HI-POCT), United States, Nov 2019.
9) **M. S. Salekin**, G. Zamzmi, D. Goldgof, R. Kasturi, T. Ho, and Y. Sun, "Multi-channel neural network for assessing neonatal pain from videos," in IEEE International Conference on Systems, Man and Cybernetics (SMC), Italy, Oct 2019.
10) G. Zamzmi, R. Paul, **M. S. Salekin**, D. Goldgof, R. Kasturi, T. Ho, and Y. Sun, "Convolutional neural networks for neonatal pain assessment," IEEE Transactions on Biometrics, Behavior, and Identity Science, 2019.

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