Digital ICU : Robust Skeleton-based Action Recognition under Occlusion in Intensive Care Unit

General Info
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Project Abstract

Patients in the Intensive Care Unit (ICU) are continuously monitored by clinicians for any signs of early clinical deterioration. Currently, this monitoring is done with the help of electronic medical devices (i.e. bedside-monitor) that measure the vital signs of patients continuously and alert clinicians whenever the vital signs are outside a predefined normal range. However, such monitoring could lead to a high rate of false-positive alerts due to the movement (action) of patients affecting the vital signs measurement (artifacts). A possible solution is to build an intelligent patient monitoring system that incorporates action recognition in the ICU to reduce artifacts and false-positive alerts. Besides this use case, such a system can also be used to identify patients that are in need (i.e. falling down, struggling to stand up) and notify clinicians to help them. Furthermore, the recognized action can serve as an additional source of information in the patient protocol, which can be used to improve patient health analysis.

This project aims to bring the aforementioned benefits of action recognition to aid clinicians in the ICU by developing a skeleton-based action recognition module for use in an intelligent patient monitoring system. While there exist many skeleton-based action recognition models [1,2] in the literature, these models may not be suitable for use in the ICU setting because of the high degree of occlusion in the ICU. The occlusion can be caused by many factors, such as patients and clinicians moving around, and patients being covered by a blanket or a large patient gown. Developing a model that is robust against occlusion will be the main goal of this project.

Task Description
- Literature review on SOTA works working on skeleton-based action recognition [1,2].
- Develop an algorithm to simulate "occlusion", i.e. masking out the leg joints to simulate the case where only the upper body is visible.
- Develop an action recognition model that gives the best trade-off between robustness (in terms of occlusion) and accuracy.
- Develop an evaluation metric to evaluate the "occlusion robustness" of an action recognition model.
- Write and present about the work that is done.

Technical Prerequisites
- Intermediate or advanced programming experience with Python3. (C++ is a plus)
- Optional: Experience using the following libraries: OpenCV, Scikit-learn, Pytorch, TensorFlow.

References
[1] YAN, Sijie; XIONG, Yuanjun; LIN, Dahua. Spatial temporal graph convolutional networks for skeleton-based action recognition. In: Thirty-second AAAI conference on artificial intelligence. 2018.
[2] SHI, Lei, et al. Two-stream adaptive graph convolutional networks for skeleton-based action recognition. In: Proceedings of the IEEE/CVF conference on computer vision and pattern recognition. 2019. S. 12026-12035.