Digital ICU : Relations and Semantic Scene Graph for Visual Scene Understanding in Intensive Care Unit

General Info
Contact Person: Ee Heng Chen
Contact Email: eeheng.chen@tum.de

Project Abstract
Scene graph is a graph that models the relationship (edges) between objects (nodes) in a scene [1,2,3,4]. It encodes the information needed to describe the context of a scene, for example, the location of objects (which includes humans) in relation to each other, the interaction between objects, and the change in the state of objects in a dynamic scene. When incorporated into a system, the scene graph will enable the system to understand what is happening in a scene. Such a situation-aware system is beneficial for settings where context is important, such as monitoring in the Intensive Care Unit (ICU). Patients in the Intensive Care Unit (ICU) are continuously monitored by clinicians for any signs of early clinical deterioration. With the help of the scene graph in a situation-aware system, the workflow of clinicians in the ICU can be analyzed to understand what patient data is being examined by clinicians when monitoring patients. This workflow analysis can help to identify if clinicians missed any crucial patient data. In addition to workflow analysis, a scene graph can also be used as a pseudo care planner that notifies clinicians what care has been provided and what care should be provided next. Furthermore, a scene graph could be used to model the dynamic context in the ICU (i.e., patients moving around, patients in distress, patients being helped by clinicians), and provide high-level information to reduce false-positive alerts in patient monitoring systems.

This project aims to bring the aforementioned benefits of a scene graph by developing a scene graph module for use in an intelligent patient monitoring system. The scene graph should be able to capture concepts that are relevant in the ICU by focusing on the relations between clinicians and medical devices.

Task Description
- Literature review on SOTA scene graphs [1,2,3,4], with a focus on objects and human scene graphs.
- Analyze and identify the objects that need to be modeled in the ICU.
- Develop a generic scene graph to model the relations of the objects in the ICU, with a focus on adaptability and expandability, i.e., varying number of medical devices and clinicians due to detection error or objects moving out of the scene.
- 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] JOHNSON, Justin, et al. Image retrieval using scene graphs. In: *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2015. S. 3668-3678.
[2] JI, Jingwei, et al. Action genome: Actions as compositions of spatio-temporal scene graphs. In: *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2020. S. 10236-10247.
[3] AKSOY, Eren Erdal, et al. Categorizing object-action relations from semantic scene graphs. In: *2010 IEEE International Conference on Robotics and Automation*. IEEE, 2010. S. 398-405.

[4] CHEN, Tianshui, et al. Knowledge-embedded routing network for scene graph generation. In: *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2019. S. 6163-6171.