

Technical Aspects of Closing the Loop in Depth-of-Anesthesia Control

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Abstract : When performing a diagnostic procedure or surgery in general anesthesia (GA), a proper introduction and dosing of anesthetic agents are one of the main tasks of the anesthesiologist. However, depth of anesthesia (DoA) also seems to be a suitable process for closed-loop control implementation. To implement such a system, one must be able to acquire the relevant signals online and in real-time, as well as stream the calculated control signal to the infusion pump. However, during a procedure, patient monitors and infusion pumps are purposely unable to connect to an external (possibly medically unapproved) device for safety reasons, thus preventing closed-loop control. The paper proposes a conceptual solution to the aforementioned problem. First, it presents some important aspects of contemporary clinical practice. Next, it introduces the closed-loop-control-system structure and the relevant information flow. Focusing on transferring the data from the patient to the computer, it presents a non-invasive image-based system for signal acquisition from a patient monitor for online depth-of-anesthesia assessment. Furthermore, it introduces a UDP-based communication method that can be used for transmitting the calculated anesthetic inflow to the infusion pump. The proposed system is independent of a medical device manufacturer and is implemented in Matlab-Simulink, which can be conveniently used for DoA control implementation. The proposed scheme has been tested in a simulated GA setting and is ready to be evaluated in an operating theatre. However, the proposed system is only a step towards a proper closed-loop control system for DoA, which could routinely be used in clinical practice.

Keywords : closed-loop control, depth of anesthesia (DoA), modeling, optical signal acquisition, patient state index (PSi), UDP communication protocol

Conference Title : ICABEB 2022 : International Conference on Advanced Biomedical Engineering and Biomechanics

Conference Location : Madrid, Spain

Conference Dates : March 21-22, 2022