

Abstract

This supplemental disclosure describes an optical–thermal camera module that extends the TraceLoop ICU adaptive-dosing platform to include real-time, vision-derived physiological inputs. A co-located RGB + near-infrared + thermal sensor array mounted above the patient extracts facial-expression pain scores, thoraco-abdominal motion, skin-color perfusion indices, edema maps, line/tube integrity, posture, and gaze metrics. These quantitative features are streamed to the existing four-tier TraceLoop hierarchy–vital-override (L-0), guard-rail (L-1), optimiser (L-2), and training (μ -band)– where they modulate drug-cartridge actuation, ventilator control, and nurse-alert logic. Examples include automated naloxone delivery for opioid-induced apnea, fentanyl micro-dosing for pain escalation, and infusion halts on visual IV disconnection. On-edge inference within an encrypted Jetson Xavier node preserves privacy; loss of camera signal triggers deterministic sensor-only fallback. The module integrates seamlessly with the audit-ledger, override interface, and conflict-graph architecture defined in FIGS. 1–10, yielding a tamper-evident, contact-free enhancement of closed-loop critical-care automation.