

ENHANCING SURGICAL TEAM COLLABORATION AND SITUATION AWARENESS THROUGH MULTIMODAL SENSING

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ABSTRACT

This research adopts a holistic view of surgery, emphasizing the vital roles of all operating room (OR) personnel and the importance of their interactions and shared awareness in delivering quality patient care. A two-phase approach is proposed: the first phase focuses on the design of a **multimodal platform** to monitor OR team members and create new metrics for collaboration and situation awareness using synchronized recordings of various signals. The second phase centers on developing **intuitive dashboards** to help surgeons review procedures and identify adverse events. This research seeks to enhance collaboration, increase situation awareness, and reduce surgical adverse events, promoting a transformative and inclusive approach to surgery.

BACKGROUND

- **Situation awareness (SA)** is an essential construct that impacts decision-making and performance in surgery, which demands robust cognitive skills.
- **Monitoring collaboration** is crucial in surgery where responsibilities and knowledge of the situation are shared among surgeons, anesthesiologists, and nurses [1, 2].
- **Existing methods** for evaluating SA and collaboration, such as questionnaires and expert ratings, are unsuitable or unreliable [3].

RESEARCH QUESTIONS

- (RQ1) How to manage ethical and technical challenges in OR multimodal data collection?
- (RQ2) How to quantify situation awareness and collaboration in surgical teams?
- (RQ3) How to create dashboards for effective surgical data analysis?
- (RQ4) How to turn data insights into actions for safer surgeries?
- (RQ5) How to build AI that predicts errors and adverse events in surgery?

APPROACH

Design of the data collection platform and metrics (RQ1, RQ2)

Phase 1

RQ1 - Setup ✓

- 1 Lavalier microphone
- 2 Physiological garment
- 3 Tracking tag
- 4 Audio transmission system
- 5 Wi-Fi router
- 6 Computer (running Microsoft PSI [4])

RQ2 - Metrics (in progress)

- 1 Speech
- 2 Physiological data (ECG and respiration)
- 3 Localization (position and orientation)

User	Team
<ul style="list-style-type: none"> Speech flow Stress and mental workload Proximity to areas of interest 	<ul style="list-style-type: none"> Overlapping speech Physiological synchrony Proximity to team members

Phase 2

Future work - Augmented insights on the surgical situation (RQ3, RQ4, RQ5)

RQ3 – Augment surgical context

How to use the metrics to facilitate reviewing surgery? To detect

- **Surgical steps and phases:** e.g., incision, suture, ligation
- **Errors:** e.g., cognitive error, communication error
- **Adverse events:** e.g., bleeding injury, thermal injury

Proposed solution - Augmenting the timeline

Stress: ▲▲▲▲▲▲▲▲▲▲

Voice activity: ■■■■■■■■■■

Activity level (motion): ●●●●●●●●●●

Time →

RQ4 – Actionable feedback

For learning	During surgery
<p>Share relevant findings: e.g., nurses who continue to communicate verbally under high-stress conditions enhance patient outcomes in x% of scenarios</p>	<ul style="list-style-type: none"> • Report anomalies: e.g., team member who does not react to changes in situation • Suggest actions: e.g., the team is overwhelmed; it is recommended to replace X

RQ5 – AI

Model training: Metrics, Manual annotations → AI model

Inference (during surgery): AI model → Predicted annotations (from Metrics)



Paper



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