Temporal Scene Understanding for Real-time DD Form 1380 Support in Tactical Combat Casualty Care

DESIGN INTERACTIVE

Kyle Whirlow, MS, **Connor Austin**, **Rebecca Criss,** MS, **JoAnn Archer,** MS, **Sascha Goto,** MA

Design Interactive, LLC, 3501 Quadrangle Blvd., Suite 150, Orlando, FL 32817

INTRODUCTION

Combat medics operating in austere environments must simultaneously assess casualties, perform life-saving interventions, communicate patient status, and document treatment on the Tactical Combat Casualty Care (TCCC) Casualty Card (DD Form 1380). Documentation requirements compete directly with patient care activities and may contribute to incomplete or delayed records.

Human-machine teaming technologies offer the potential to reduce documentation burden by continuously observing care activities and generating structured documentation support in real time. Previous work demonstrated the feasibility of automated TCCC procedure recognition through machine perception. The current effort extends this capability through temporal scene understanding and procedural state estimation to support real-time DD Form 1380 completion at the point of care.

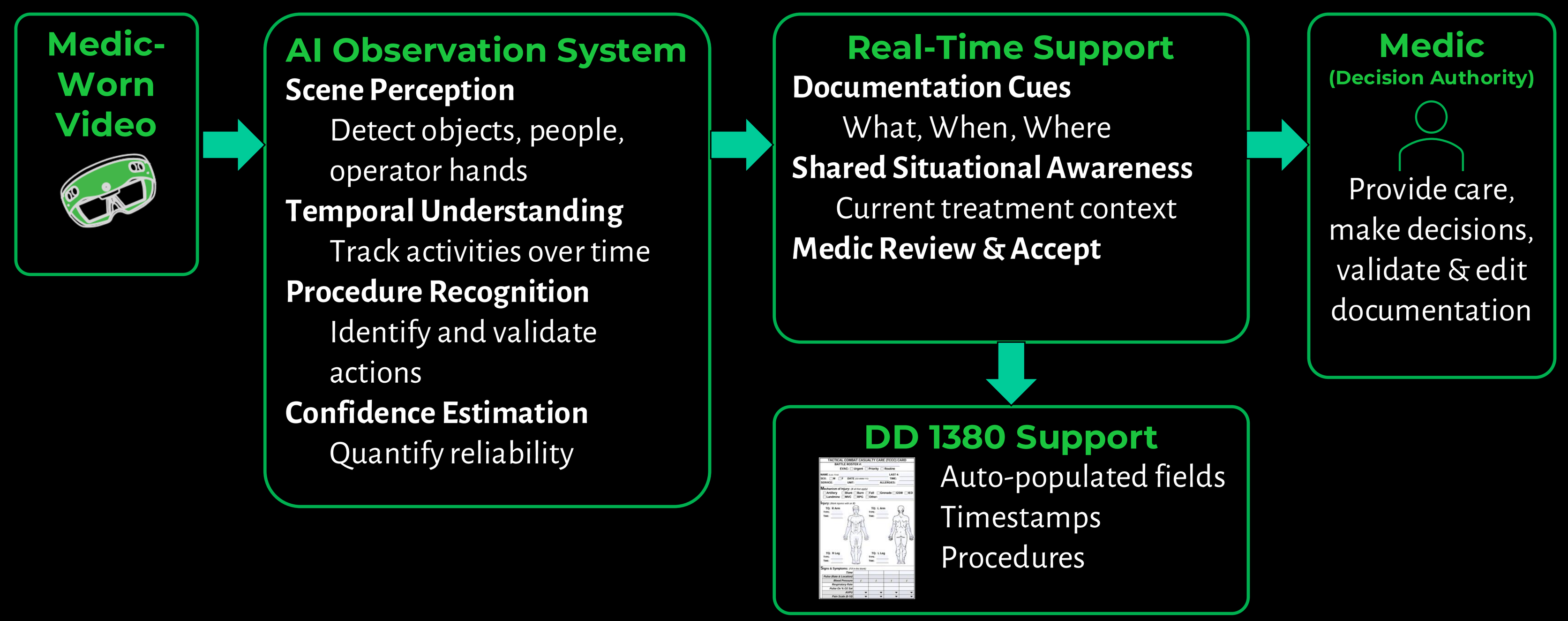
Objectives

- Reduce medic cognitive burden during casualty care
- Improve accuracy and completeness of DD Form 1380 documentation
- Enable real-time documentation support on edge hardware
- Enhance situational awareness through temporal understanding of ongoing care activities
- Establish a foundation for future semi-autonomous medical assistance systems

System Overview

The system acts as an AI teammate that observes casualty care activities, interprets procedural state, and generates structured documentation cues.

Figure 1: Human-Machine Teaming Architecture.
AI system observes care activities and provides real-time documentation support while the medic maintains decision authority.



Technical Overview

Scene Perception

The system processes medic-worn video streams to identify personnel, casualties, medical equipment, and treatment activities occurring within the scene.

Components

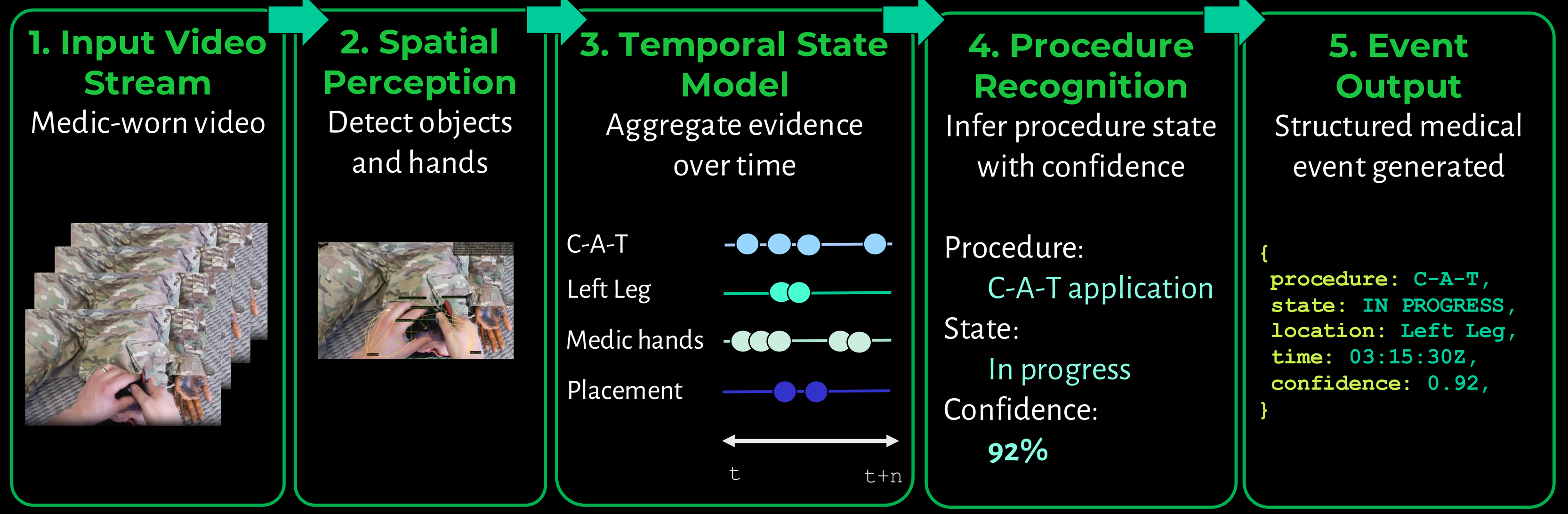
- Object Detection
- Human Pose Object Detection
- Activity Observation
- Spatial Relationship Analysis
- Context Extraction

Temporal Scene Understanding

The traditional perception approach previously applied primarily relied upon object detections and motion patterns. This effort introduces a temporal state architecture that integrates object interaction through medic hand pose touch-points and object scene placement across time to maintain awareness of evolving medical procedures.

Frame-by-Frame Object Awareness:	"What objects are present in this frame?"
Temporal Understanding:	"What stage of treatment is currently occurring?"

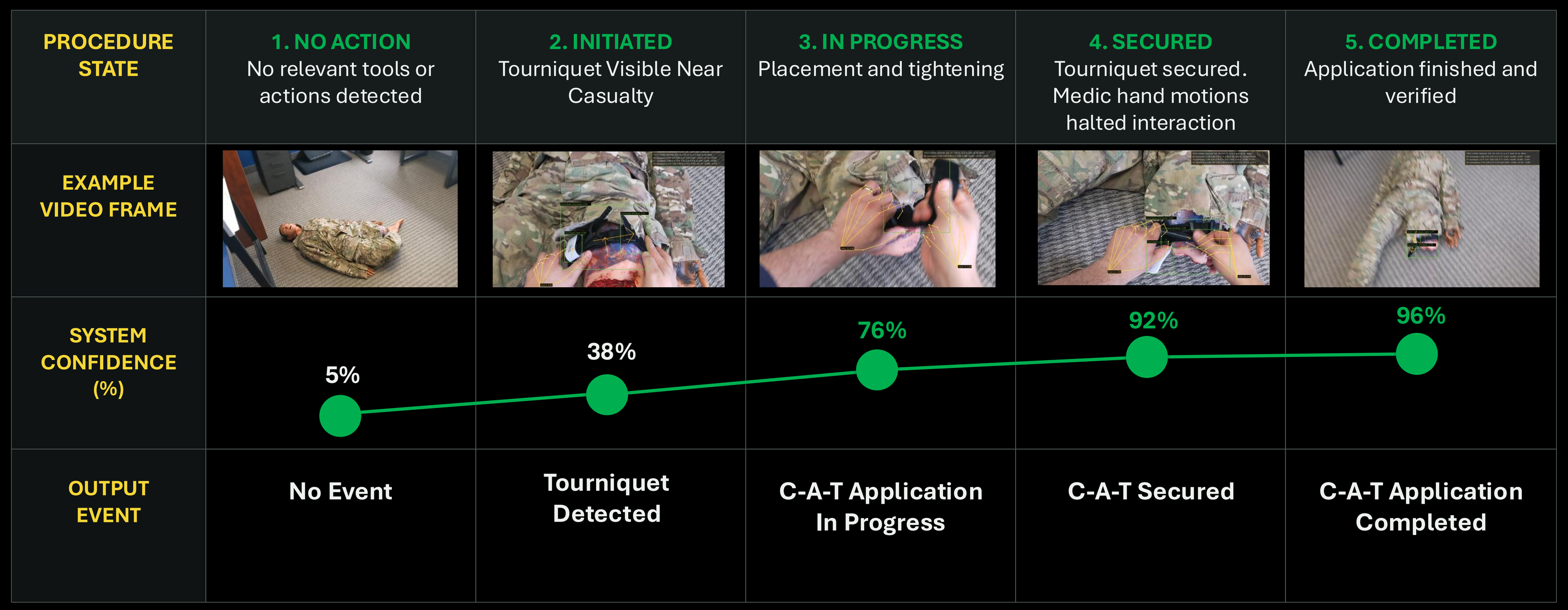
Figure 2: Temporal Scene Understanding Pipeline.
Integrates spatial detections with temporal state estimation to recognize procedures as they unfold.



Key Advantages of Temporal State Approach

- More robust to occlusion, motion blur, and lighting changes
- Distinguishes active treatment from incidental activity
- Maintains awareness of procedure progression
- Higher confidence, fewer false positives

Figure 3: Procedure State Transition Example.
Example temporal progression for a tourniquet application.

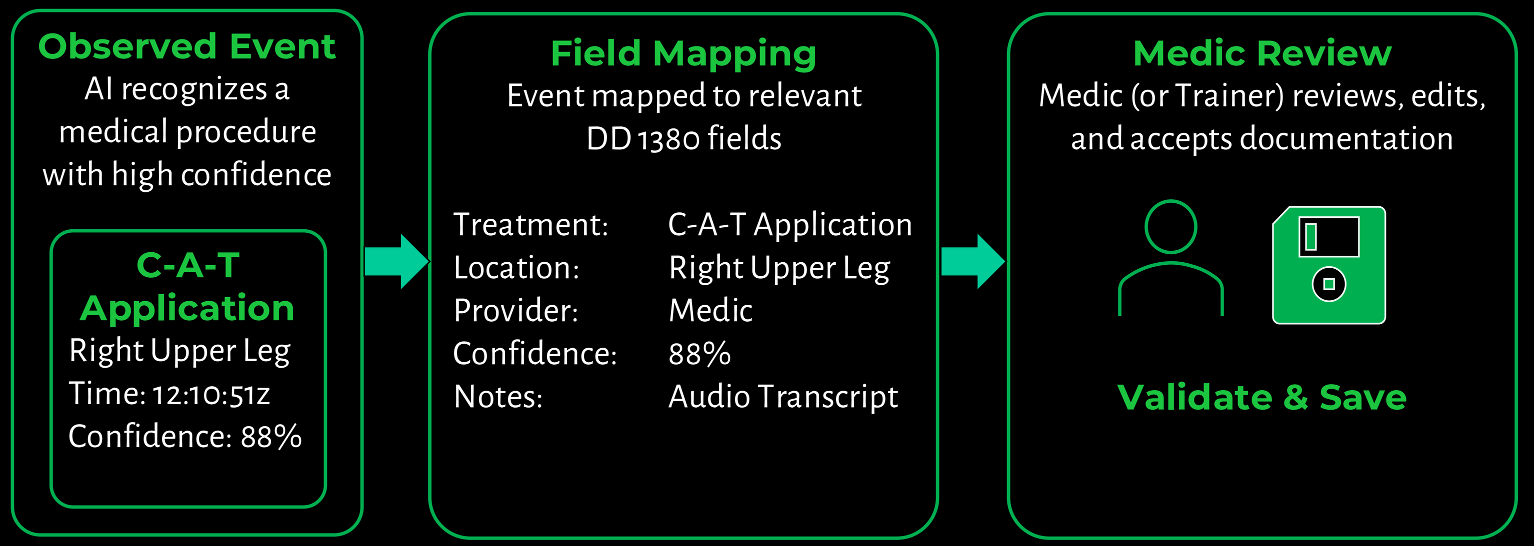


The temporal scene understands progression based on positioning of relevant objects, medic hand placement and motions, medic focus areas, and touch duration.

Human-Machine Teaming

The AI system functions as an assistive teammate rather than an autonomous decision maker.

Figure 4: DD Form 1380 Auto Population Workflow.
Recognized events are translated into structured documentation fields for review and validation.



Referenced Works

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2. VanVoorst, B., Walczak, N., Gilleo, C., Meissner, C., Felix, F., Roman, I., Steers, B., Silva, C., Shen, Y., Lu, Z., Lee, S.-P., & Elhamifar, E. (2026). EgoMAGIC: An egocentric video field medicine dataset for training perception algorithms. arXiv preprint arXiv:2604.22036.
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RESULTS

Figure 5: Current Capability and Development Progression.
From scene perception to hand-aware temporal state estimation and structured documentation support

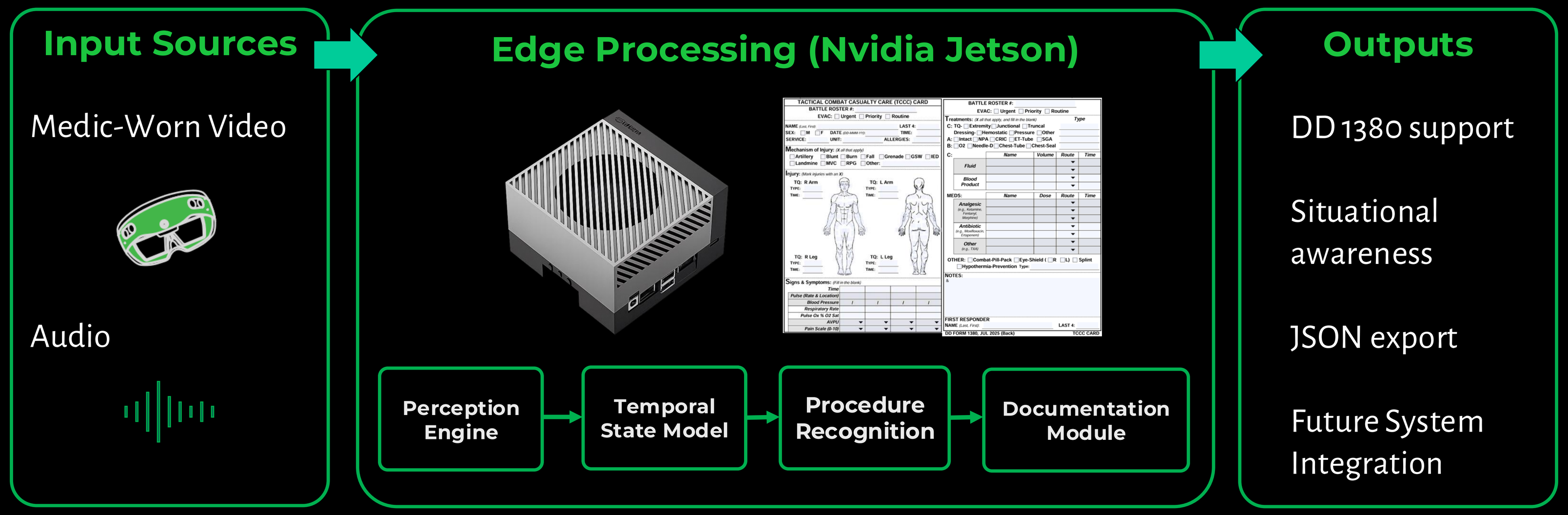
Capability	Current Implementation	Operational Value
Scene perception	Detects care-relevant objects, hands, and motion	Identifies treatment context
Hand-aware geometry	Tracks hand position, hand-object overlap, and relative motion	Distinguishes interaction from incidental visibility
Temporal state estimation	GRU aggregates visual evidence over time	Estimates the current treatment state
Documentation support	Emits procedure, state, time, location, and confidence	Creates DD Form 1380-ready cues

PRELIMINARY VALIDATION

	Object + Motion GRU	Hand-aware Geometry	Relative Increase
Accuracy	25.3%	37.7%	49%
Macro-F1	18.9%	24.1%	28%

Edge Deployment Architecture

Figure 6: Edge Deployment Architecture (Nvidia Jetson).
Processing occurs locally on edge device for reliable operation in tactical and training environments.



CONCLUSION

We present an edge-deployed temporal scene understanding architecture designed to function as a human-machine teammate for Tactical Combat Casualty Care documentation. By maintaining an evolving representation of medical procedures over time, the system provides recognition of treatment activities and supports real-time DD Form 1380 completion.

Preliminary evaluation showed improved accuracy and Macro-F1 compared with the object-and-motion GRU baseline while enabling contextual documentation support directly at the point of care. These capabilities establish a foundation for future semi-autonomous medical assistance systems that enhance documentation quality, reduce cognitive burden, and improve continuity of care across the casualty evacuation chain.

FUTURE WORK

Near-Term Development

- Expanded TCCC procedure library
- Treatment recognition capabilities
- Improved temporal reasoning model
- Multi-casualty scene awareness
- Resource and supply tracking

Advanced Human-Machine Teaming

- Automated care summaries
- Context-aware recommendations
- Patient identification integration
- Medical inventory awareness
- NLP interaction capabilities

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