Demo Abstract: IMACS - An Interactive Cognitive Assistant Module for Cardiac Arrest Cases In Emergency Medical Service

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ABSTRACT

IMACS is an intelligent, interactive cognitive assistant dedicated to cardiac arrest cases in Emergency Medical Service (EMS). EMS providers deal with many cardiac cases. IMACS interacts with EMS providers in real-time and collects vital information from the providers' conversation, including names of interventions, timestamps of interventions, and dosage amount. Throughout the process, IMACS provides necessary reminders and creates a summary report afterward. Using the dynamic behavioral model of two different cardiac arrest recovery protocols, we have developed a critical risk-index based approach to provide time-sensitive feedback and suggest alternatives to the providers in real-time. Our experiments reveal an F1-score of 83% with 300 test cases. A qualitative study also reflects that seven out of ten of the EMS providers rate the system as very helpful in correctly executing cardiac arrest EMS protocols.

CCS CONCEPTS

• **Human-centered computing** → *Interaction design*; • **Computing methodologies** → **Natural language processing**; • **Social and professional topics** → **Medical technologies**.

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1 INTRODUCTION

Cardiac arrest is a complex, life-threatening health condition and one of the leading causes of death in the USA. In addition, it can also result in neurological injury, functional disabilities, and increased healthcare costs [Graham et al. 2015]. Several factors can affect the outcome of an out-of-hospital cardiac arrest, one of which is the efficacy of emergency medical service (EMS) providers who provide initial care to the patient. Properly executing the cardiac arrest protocols in real-time poses a significant cognitive load on the care providers. To aid the EMS providers in properly executing cardiac arrest protocols, we have developed **IMACS**, an Interactive Cognitive Assistant Module for Cardiac Arrest Cases In Emergency Medical Service. As the EMS providers constantly communicate with each other at an emergency scene, IMACS collects and utilizes such conversational data. The underlying behavioral model of IMACS addresses the technical challenges to provide real-time cognitive assistance to the providers to (i) ensure proper execution of the protocols, and (ii) improve the medical outcome of a cardiac arrest incident.

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2 SOLUTION OVERVIEW

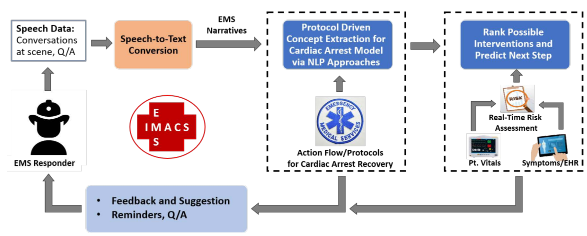

Figure 1: Solution for providing real-time suggestion

IMACS runs on a laptop which processes the conversation of the EMS providers in real time. Using real time speech-to-text conversion techniques [Google [n.d.]], a live transcription of the emergency scene is produced. The cognitive system discussed in [Preum et al. 2018] presented a voice-based cognitive assistant system for suggesting interventions to the EMS providers. Unlike this previous work, IMACS is an interactive, real-time assistant and provides dynamic, customized suggestions for cardiac arrest EMS protocols. Applying natural language processing techniques, behavioral models are developed for identifying critical concepts from the cardiac arrest cases. Most cardiac arrest procedures follow a combination of dynamic but sequential processes for recovery. A typical flow of actions approved by certified EMS providers is used as a model for our system. We have also developed algorithms to decide the severity of the situation, an ill-timed action under specific circumstances is given a risk-index according to it's severity. Combination of allowed interventions by the acting EMS provider and the risk-index determines the dynamic critical-index. This risk-index further decides the nature of feedback mechanism. Figure 1 shows a high-level solution overview.

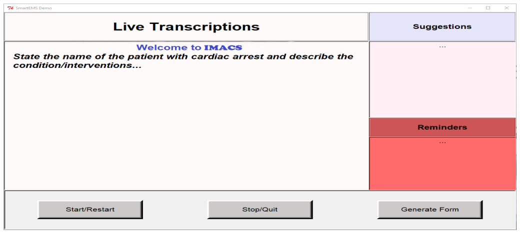

Figure 2: IMACS module interface

Figure 3: A snapshot of working version of IMACS

Table 1: Description of synthesized dataset for Cardiac Arrest Cases

Type	Description	Quantity
Text	RAA narratives	100
	Noise-inserted RAA narratives	100
Audio	Noisy audio (ambient noise)	10
	Noise-free audio	10
	Audio with artificially injected noise (using 8 noise profiles)	(10*8) = 80

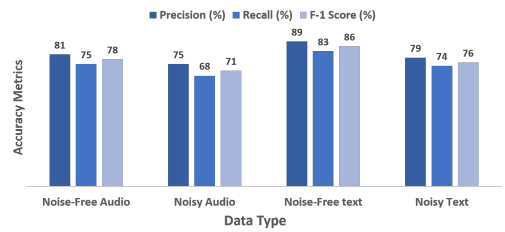

Figure 4: Accuracy of IMACS

3 DEMONSTRATION

3.1 App Details

Figure 2 shows the module interface of IMACS. Python 3.6 is used to develop the module, to ensure competence and consistency with our previous work [Alemzadeh and Devarakonda 2017]. The module is started by an EMS provider while providing care to the patient. An omni-directional microphone is used to capture the audio stream. The live transcription of the audio comes up on the left window, the suggestions and reminders pop up on the right side. The module is started by the button *Start/Restart*, and stopped or paused by *Stop/Quit* button. While the interventions are mostly continuous, the care provider can use the module both in continuous and discrete manner. After the scene is done, clicking the button *Generate Form* creates a summary report for the patients as discussed in [Rahman et al. 2020]. This step also creates a log for all the interventions completed by the EMS providers with their respective timestamps.

Figure 3 shows a snapshot of working version of IMACS. The module color codes each information and provides suggestions and reminders accordingly. As soon as the care-provider verbalizes that a cardiac arrest case is detected, suggestions and reminders pop-up with time-stamp in the same color-coded manner. Further information extracted from the description/conversation of the care providers prompts subsequent feedback from IMACS, with necessary alerts to switch providers when specific time is up or severity of the situation changes. If the suggestion of IMACS is not followed by the provider, an alert message pops up, for example if Ćompressionṕrocedure is not started after the suggestion by IMACS at 10:23 time, an alert draws the attention of the providers. Here in Figure 3, that procedure is found (marked in green) thus there is no alert shown. Due to space limitations, we do not provide further elaboration of the system here. [1]

[1]A preliminary video demo of IMACS: https://rb.gy/lgebva

3.2 Experiment: Data Collection and Labelling

As live data collection in real EMS scenes requires certain approval and holds privacy concerns, we collaborated with regional EMS provider organizations to collect the post-scene transcript. We applied a style transferring mechanism to recreate conversational data. Table 1 shows the sources of our dataset.

3.3 Experiment: Results

Randomly selecting half of the data from Table 1 as training set, we tuned IMACS for real-time feedback. Figure 4 shows that for all different types of data, average F-1 score is 83% for testing dataset. The error is mainly due to the inaccurate transcription from the speech-to-text engines, noisy surroundings affect IMACS adversely. Some of the error is caused by out-of-flow actions by the providers.

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