Human Machine Team (HMT) Architecture Design For Live Virtual Constructive (LVC) Environment Towards Training Medical First Responders

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Introduction

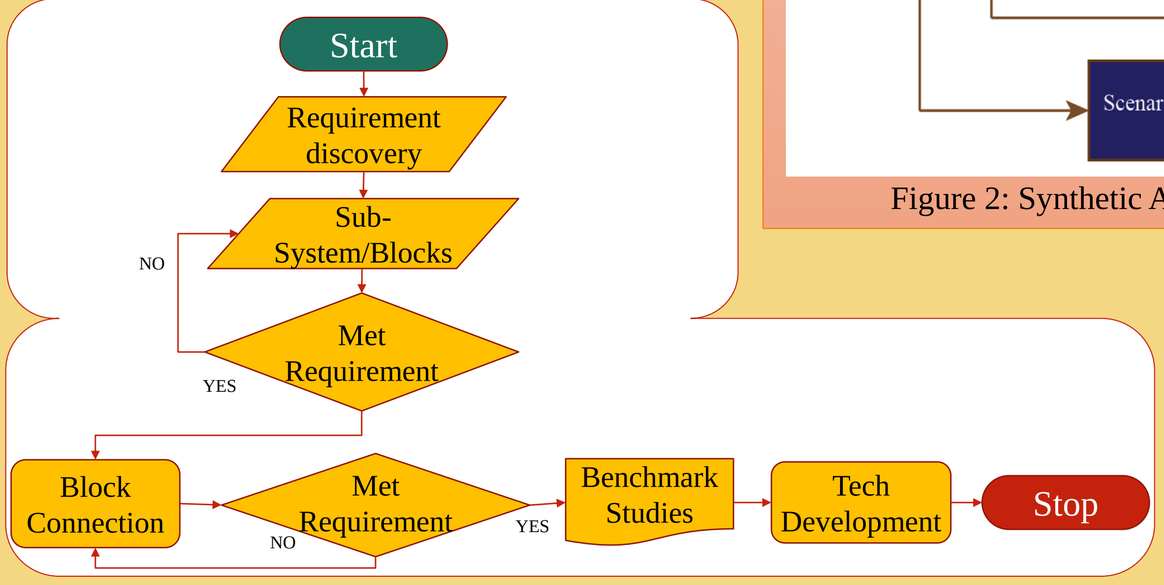
- Studies indicate that errors during patient's transfer of care (TOC) causes 250,000+ deaths annually across the US
- Training of medical first responders within the LVC environment is critical
- Techniques/technologies learnt should be used in the field
- Project subject matter experts (SME) identified challenges faced by first responders in the field and during training, including:
  - ➢Handoff communication breakdown
  - ➢Different technical language among caretakers at different levels
  - ➢Difference in equipment functional knowledge used in field and hospital
  - ➢Sensitive time of response in the emergency first responder environment

Problem statement

- Study effects of use of Synthetic Assistant (SA) in the LVC training environment
- Minimize/reduce errors in TOC by augmenting medic capabilities
- Explore issues in HMT architecture development to be used in such scenarios

Procedure

- ***Survey***: 29 autonomous system architectures explored to develop/implement an HMT
- ***Discovery***: Benchmark HMT architecture doesn't exist yet
- ***Focus***: Design evidence-based HMT architecture through agile process for use in LVC training of medical first responders
- ***Result***: A feasible solution may be the following abstract process (flow chart)



Requirements Development

- ***Requirements***: Identifying
  - ➢machine related tasks,
  - ➢humans related tasks, and
  - ➢potential methods of interactions.
- Insights on possible errors by first responders and several real-world scenarios have been provided to our technical team by SMEs.
- Three human elements in TOC identified through scenario analysis are:
  - ➢Soldier/companion of injured (S),
  - ➢Casualty evacuation team (C), and
  - ➢Frontline military hospital staff member/surgeon (H).
- ***Proposed addition***: The machine or the SA.
- ***Result***: HMT contains SA (machine) and three types of first responders (human team members).
- Figure 1(a) contains sample requirements of SA for each human element

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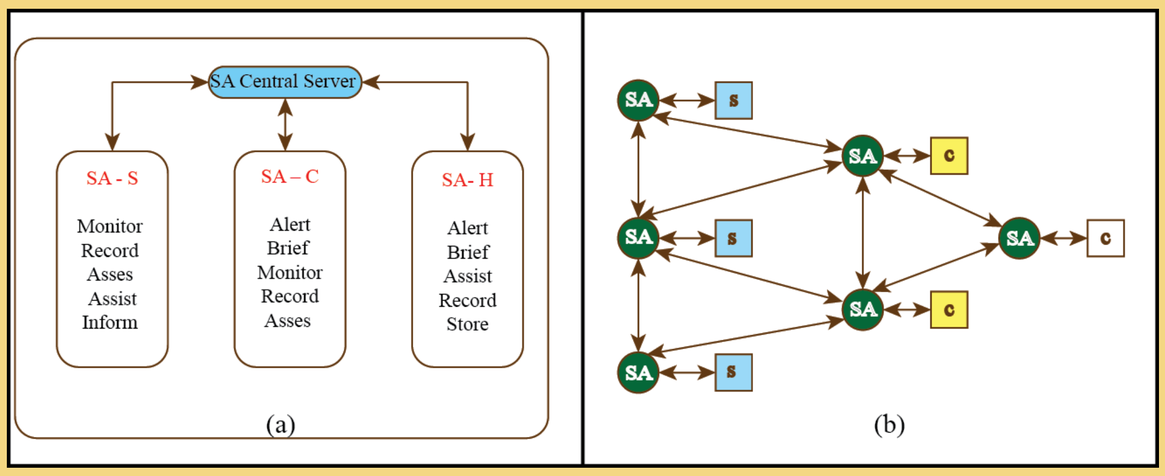

Figure 1 : (a) Sample Requirements of SA for each team member, (b) Sample Proposed HMT Network Architecture

System Design

Design: 3-tier (interaction, system state, decision support), 2-dimensional (personal/global SA) (see Figure 1(b), 2)

SA: 24x7 monitoring system

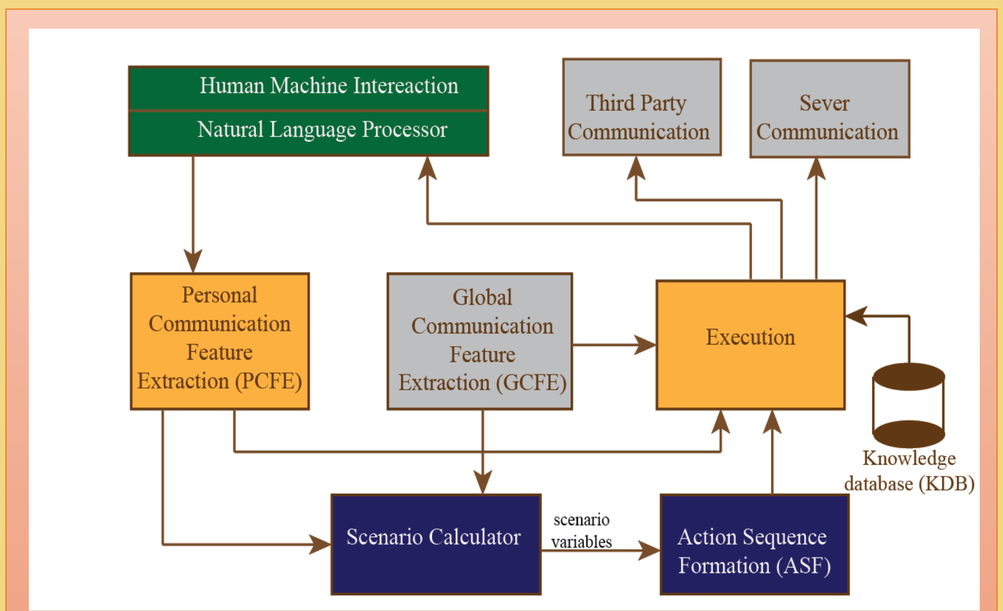

Figure 2: Synthetic Assistant (SA) of HMT Architecture

SA Components: 6 blocks:

- *Personal Communication Feature Extraction (PCFE)*: Uses communication channels to extract important words + confidence (C_f)
- *Global Communication Feature Extraction (GCFE)*: Uses communication channels + background audio to extract important words and sounds + C_f.
- *Scenario Calculator*: Uses word sequence, frequency, and C_f as inputs, identifies *scenario variables* to be transmitted to the ASF.
- *Action Sequence Formation (ASF)*: Identified tasks/actions pushed into the action table with a ranking. Example sequence - procedure → checklist → task allocation → *(KDB)*: Contains detailed steps of various medical procedures such as information exchange
- *Knowledge database:* First Aid + checklists for tasks to cross-check human actions.
- *Execution*: Uses action table ranking + checklists to cross-check actions, processes narration and communicate information. Sends inferences to voice synthesizers or communication networks for HMI.

Discussion and Conclusion

- Including C_f in SA architecture addresses trust in the HMT
- Limitations arise as system is based on analysis of limited scenarios
- Possible limitation in practical use due to delay in HMI
- ***Future***:
  - ➢Implementation of architecture in real-time
  - ➢Studying operational performance of different blocks within HMT
  - ➢Envisage "SA + humans = HMT" by introducing a "team-building" step.

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