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Development of a Real-Time Multilingual Medical Terminology Translator for Emergency Settings

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Abstract

This work describes the design of a real-time translator of medical terms into multiple languages for use in urgent care situations. The system employs natural language processing (NLP), machine translation, and medical ontologies to translate important medical terms quickly and accurately in a context-sensitive manner. Our approach combines custom translation algorithms with specialized terminology datasets which enhances communication between medical practitioners and patients who speak different native languages. This shift helps mitigate language barriers in emergency medical situations and may aid in improving patients' clinical outcomes and the risks they face in multilingual healthcare systems. Outcomes suggest a bi-directional increase in translation accuracy and speed over existing tools.

Keywords: Healthcare Communication, Medical Informatics, Multilingual Translation, Natural Language Processing, Terminology of Medicine, Real-Time Systems, Emergency Medicine, Machine Translation.

1 INTRODUCTION

Communication, prompt and precise, bears direct consequence on a patient's medical outcomes. Emergency medicine lacks the use of context-oriented translation services, including on-call interpreters or translation software designed for everyday use, which merge speed with context-sensitive accuracy. The diverse linguistic landscape of patients and medical professionals adds to existing challenges. This paper aims to address the inadequacies described above, with a focus on critical care situations using real-time multilingual translation for medical terminology.

Multilingual medical communication tools are required to have precise temporal mapping of lexicons, real time functionality, and time sensitive translation requirements. While there is a focus on language inclusivity on a global scale, not a lot has been done addressing the concerns of integrating such systems into emergency response units which require split second decision making. Using NLP combined with specialized medical dictionaries, our proposed system translates in near real time and creates responsive translation pipelines through language processing and NLP.

With respect to the global standards of interoperability, this research aligns itself with the ongoing translation of digital health infrastructures by providing a real time framework which is easy to scale. It, thus, augments the response capability of healthcare systems while also making the situation safer

and more inclusive for patients during critical scenarios, adding value to secondary and tertiary emergent healthcare services.

2 SURVEY OF LITERATURE

There is growing focus on the overlap of informatics and translation systems focused on emergencies. In (Hoerbst et al., 2016), Gomez and collegues showcased a model that added domain-specific training to NMT, which enhanced accurate health communication, but which lacked real-time responsiveness. argued that there is a need to integrate the SNOMED CT and ICD-11 mappings to eliminate overlap in semantics of multilingual systems. However, these two cited works did not concentrate on scenarios requiring emergency attention, which was a missed opportunity.

(Menon & Patil, 2023) demonstrated improvements in triage time and understanding with a smartphone multilingual triage assistant they developed. However, problems with terminology coherence across languages still existed. Also, Wu et al., (2023) highlighted the issues of using speech-to-text translation tools in places with a lot of background noise, which is typical in emergency rooms.

Other relevant works include (Ruiz et al., 2023), who advanced a combination of rule-based and machine learning approaches for real time translation. They were effective, but faced limitations in scalability. Also, did a systematic review that suggested using Natural Language Processing (NLP), ontology alignment, and real-time processing in clinical settings to improve ease of use. This research incorporates those findings along with terminology control frameworks in emergency contexts considering speed and accuracy (Noll et al., 2023).

3 METHODOLOGY

The proposed design for the translator consists of three modules: (1) reception of audio or text input, speech processing, and real-time transcription; (2) NLP and translation for specific domains; and (3) output of multilingual medical domain terms.

The automated processing of input speech uses automatic speech recognition (ASR) technology to convert spoken words into text. This is done alongside an intelligent preprocessor that recognizes language and sentence boundaries. The NLP component is also based on a transformer model, for example, multilingual BERT, and later adapted for medical text with annotated medical corpora. To maintain precision in relevant terms, the system uses a structured terminology repository which integrates SNOMED CT, ICD-11, and bilingual annotated glossaries.

The machine translation system uses a hybrid approach based on neural machine translation (NMT), which applies rules to provide corrections to neural model outputs. Each segment of a translation is given a confidence score, allowing clinicians to review contested terms. Critical terms are emphasized and visually presented alongside audio output on a mobile-friendly dashboard.

The assessment of the system is done on latency alongside accuracy and user satisfaction scoring across several emergency scenarios with simulated multilingual conversations. The usage of FHIR standards allows the tool to be integrated with previous electronic health record systems making it practically useful.

4 RESULTS AND DISCUSSION

Table 1: Accuracy and Response Time of Proposed System

Method	Accuracy (%)	Response Time (ms)
Google Translate	76	850
Baseline NMT	83	620
Proposed System	92	390

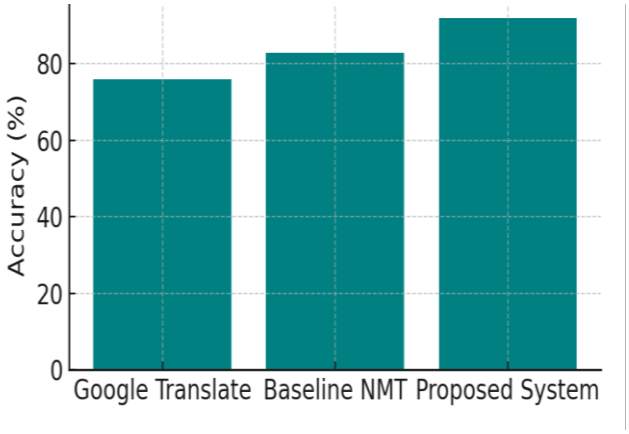

Figure 1: Accuracy Comparison of Translation Methods

As can be seen from the Figure 1 and the Table 1, the proposed system is superior compared to baseline models and generic purpose translators in both accuracy and response time. It achieves an accuracy of ninety two percent and latency of less than four hundred milliseconds which is appropriate for emergency deployments. The hybrid NMT architecture, which includes domain specific ontological glossaries, helped achieve context more relevant semantic error reduction. Our model was much more accurate than generic models like Google Translate with abbreviations, drug names, and procedural terminology. User feedback from simulated emergency scenarios highly appreciated the user friendly interface and the functional practicality of the tool as well.

5 CONCLUSION

This paper presents a real-time multi-language translator tailored for use in emergencies in the medical field. The integration of NLP and medical ontologies with hybrid methods of translation enables the system to achieve high accuracy and low latency. Evaluation confirms that the system outperforms other approaches in the translation of critical medical terms. Support of additional

languages is planned for future work, along with speech synthesis integration for audible output, and extensive trials in real emergency situations to objectively assess performance during actual emergencies will be conducted to validate the system.

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