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COMPUTER ASSISTED COMMUNICATION FOR THE HEARING IMPAIRED FOR AN EMERGENCY ROOM SCENARIO

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ABSTRACT

While there has been research on computerized communication facilities for those with hearing impairment, issues still remain. Current approaches utilize an avatar based approach which lacks the ability to adequately use facial expressions which are an integral aspect to the communication process in American Sign Language (ASL). Additionally, there is a lack of research into integrating a system to facilitate communication with the hearing impaired into a clinical environment, namely an emergency room admission scenario. This research aims to determine if an alternate approach of using videos created by humans in ASL can overcome the understandability barrier and still be usable in the communication process.

Keywords

American Sign Language, ASL, computer assisted communication, deaf communication facilities, emergency room admission

INTRODUCTION

In an emergency room admission scenario, time is critical to a successful outcome. In the event of an emergency admission of an individual with hearing impairment, a remote virtual translation, video remote interpreting (VRI), is employed. While a computerized translation system will likely never replace human interpreters it may successfully augment human interpreters, particularly when an interpreter is unavailable. In the case of VRI, communication to the remote interpretation facility is required in order to video conference for American Sign Language (ASL) interpretation. In the event of an emergency admission scenario, a failure of technology could have disastrous consequences. In this event, we propose a system to assist in obtaining the most critical information from a hearing impaired individual. The proposed system could be modified to match an individual emergency room's requirements. Previous systems have suffered from a lack of understandability. Our efforts aim to increase the understandability between a hearing person and one with a hearing impairment.

RELATED WORKS

Computerized translation systems have been studied for decades. ASL does not follow the same grammatical structure as standard American English; therefore, automated translation is difficult to achieve. Additionally, individuals who are born deaf use ASL as a native language with English as a second language; therefore, it is unreasonable to expect the deaf to understand the American English grammatical structures as would a native speaker. ASL is more than hand signals and contains other types of communication such as facial expressions. For example, eyebrows downward indicates a why or how question (WH-Question), raising eyebrows while leaning the head forward and holding the last sign indicates a yes/no question and beginning the sign with a "not" while shaking the head side to side, pursing lips and frowning indicates negation (Liddell 1980).

Previous work has uncovered some of the difficulties with automated English to ASL conversions. Zardoz, an AI research system for machine translation, aimed to translate English text into fluid sign language (Veale et al. 1998). Zardoz employed a virtual signer into spatial areas in order to generate the signs from text. Spatial concepts were also explored in (Huenerfauth 2004) where 3D modeling was employed to generate classifier predicates. Grieve-Smith (1999) performed automated translation of English weather reports into ASL. The method incorporates a writing system for expressing sign language based on literal orthography (Yule 1986); however, the system generated text and not actual ASL. Following the technique of generating semantic representations from text, Sáfár et al. (2001) used NLP techniques to generate an intermediate semantic structure that may be converted into a sign language. Machine learning and natural language processing, specifically statistical machine translation, used a corpus of bilingual documents to automatically learn the translation from text into Glosses, a notation of words for another language (Bungeroth et al. 2004). The aim of the research was to generate the translation module of a system to automatically generate sign language. Following the theme of employing NLP and a corpus, Morrissey et al. (2005) used a corpus of English and a corpus of annotated ASL videos in an example-based machine language translation approach.

Avatar based approaches to generating ASL are documented in academic literature as they assist in capturing the spatial information contained within ASL. Converting signs to virtual avatars was conducted in (Bangham et al. 2000) where sensors and cyber gloves were connected to humans, humans performed the signs, and the sensor data was used to create a virtual interpreter using DirectX technology. One example takes English input and generates an intermediate text where grammar and word order can be processed and then converted into ASL signs (Zhao et al. 2000). A similar process was followed in (Kennaway 2002) where a four step process was employed. First, text to semantic representation occurs followed by semantic representation to a sign language representation which is then converted into a sign gesture which is applied to an avatar

An approach by using an interface to permit users to create signs using an avatar was proposed in (Jemni et al. 2007). The system, Websign, gives an interface for sign generation. The concept is a community could use the system to generate a large dictionary of signs thereby facilitating automated translation. Building on the statistical machine learning techniques in (Bungeroth et al. 2004) and the multi-step process of (Kennaway 2002; Zhao et al. 2000), Othman et al. (2011) first converts input text into the semantic structure of Gloss, then passes the Gloss into Websign, as proposed in (Jemni et al. 2007), for translation into ASL.

The need for facial gestures was recognized by (Van Zijl et al. 2003) where a text-to-sign language system was proposed for South African Sign Language (SASL). A case was presented where a sign had different meanings based upon the facial gestures. Cox et al. (2002) presents a system, Tessa, for communication with the deaf which is similar to the study proposed within this research. Tessa uses speech recognition as opposed to text, automated translation to sign-language, then presentation via an avatar. As described in (Bangham et al. 2000), sensors and cyber gloves were applied to a human in order to generate the signs for the virtual human. A scenario involving communication between a postal clerk and a person with hearing impairment was conducted using Tessa. The available language and commands were limited and based on prior transactions which were modeled at the post office. While the system was novel in design, understandability was hindered by the complexity surrounding facial expressions, much as stated in (Van Zijl et al. 2003). Testing revealed that facial expressions need improvement, the delay between when the postal clerk begins speaking and the system generates translation reduced, displaying text to assist in understandability, as well as improving the appearance of the avatar.

In order to extend the research on automated communication facilities with the hearing impaired, this research attempts to address several gaps. First, speech processing will be removed in favor of a guided scenario to insure errors are reduced, in lieu of avatars and virtual humans actual hearing impaired persons will generate ASL videos that correspond to English words or phrases which will overcome the aforementioned issues with lack of understandability due to inadequate facial expression, and the system will be applied to an emergency admission scenario in a hospital where a it is not possible to utilize a human interpreter due to a range of issues with the aim of collecting valuable information during a time critical event until a human interpreter is made available either in person or via VRI.

METHODOLOGY AND RESULTS

First, a flow of information in potential emergency room scenarios was extracted from WebMD (2013) which include potential drug allergies, common trauma, heart attack, stroke, and appendicitis symptoms. The flows are diagrammed as figures 1-5. Each emergency room would design the flow of questions to suit the local operation. For example, in areas with a high number of illegal or prescription drug abusers additional questions may be added or rearranged to determine which type of drugs are abused. Additionally, in areas with high instances of heart attack events the heart attack flows could be moved earlier into the communication process. There are additional scenarios that are not modeled in this pilot communication system that may be addressed on a facility by facility basis.

The application was developed in the Visual Basic.Net programming language. The application was designed to run on a split screen. The primary screen contains the communication board shown in Figure 7 and the secondary screen contains a Windows Media Player. The communicator (non-deaf hospital staff) interacts with the communication board while the deaf/ hearing impaired views the videos on the secondary screen and replies with yes/no answers to questions. The first step is to select either native ASL or literal translation with the default set to native ASL. Additional communication mediums may be built in to the communication board by adding other options. One such example would be a method for communicating with those with minimal language skills (MLS). A MLS individual is neither fluent in ASL or English; therefore, may require a custom scenario to best extract information from the MLS individual. The first button is clicked which will instruct the deaf/ hearing impaired individual(s) that they are to respond with a yes/no and to not expand upon their answers and that an interpreter will be coming to assist. Once the program flow begins, the deaf/ hearing impaired individual(s) will be presented with a video corresponding to the questions on the communication board. In order to test the communication of the ASL and literal translation, the videos were not captioned per the Americans with Disabilities Act (ADA) requirements. Since our current subjects are native English speakers this would render the testing of the ASL communication invalid. In the event the system was installed for use in an actual emergency room the videos would be captioned. The deaf/ hearing impaired will provide a yes/no answer to each question. The scenarios and program flow are built into the software; therefore, after clicking on the first button the flow is automated and requires no knowledge of the hospital staff. The deaf/ hearing impaired individual answers the question and the hospital staff will select the appropriate option in a message box. The answers to the questions will determine the flow of the rest of the program. Besides program flow, answers to critical questions will be recorded so they may be viewed by clinical staff when beginning treatment.

Testing is in the preliminary stages. The testing participants were recruited from the ASL interpreting major and were students in junior or senior status who were approaching fluency in ASL. The testing facility consisted of the participant and the investigator. The investigator interacted with the communication board while the participant watched the corresponding videos and responded yes or no in ASL. The layout of the testing facility is shown in Figure 6. Preliminary results show that the system is capable of soliciting basic communication between a deaf individual and the emergency room staff. Participants believed the system could be useful and facilitate communication. Additionally, the participants chose a scenario consisting of medical symptoms for a sample communication. For each attempt, the correct symptoms were extracted from the participant showing the potential for future research and development. The preliminary results are determining if the system can be understood by the deaf/ hearing impaired; however, future work will test the design of the communication board and program flow from the perspective of hospital staff.

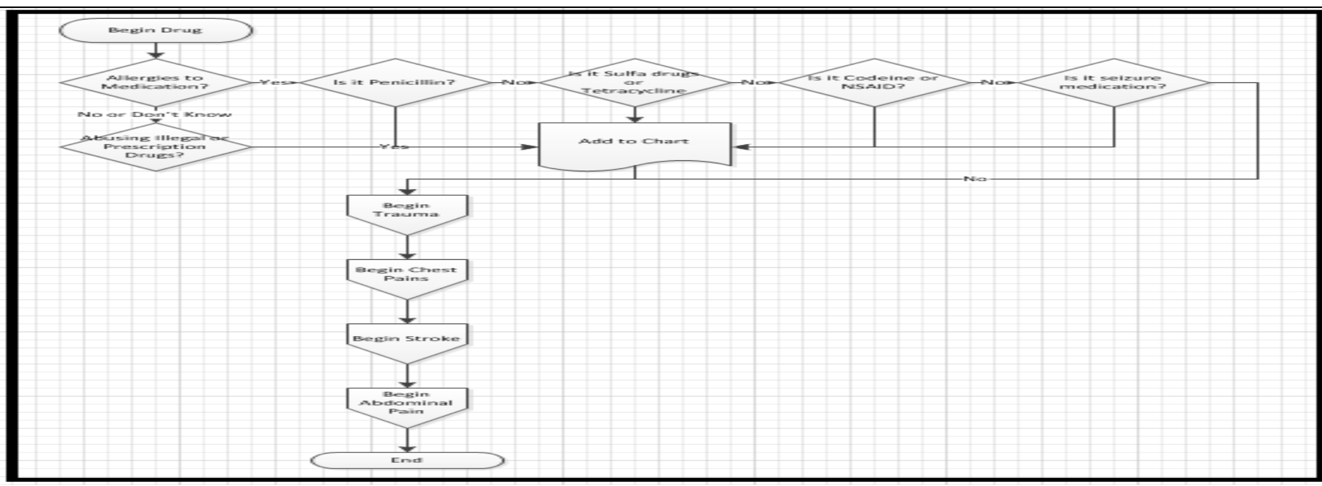

Figure 1 – Main Flow of Information Extraction and Drug Allergies

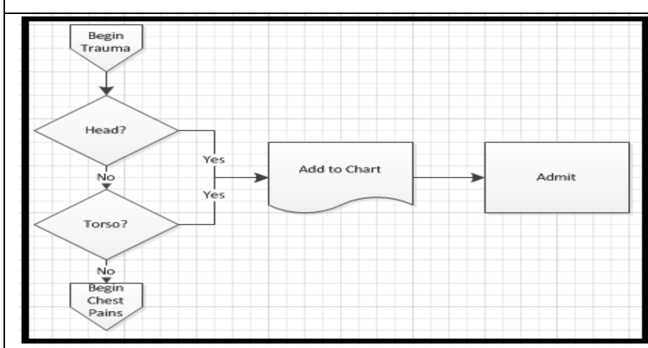

Figure 2 – Trauma Flow

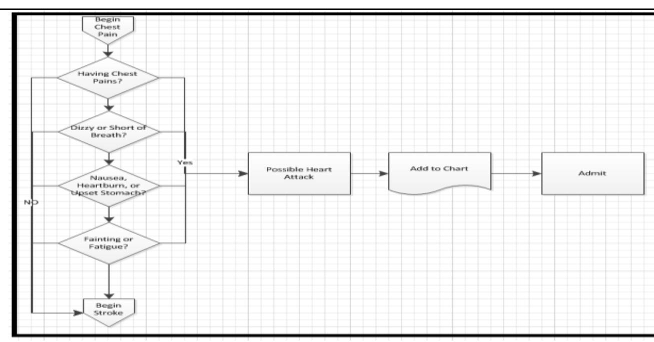

Figure 3 – Heart Attack Flow

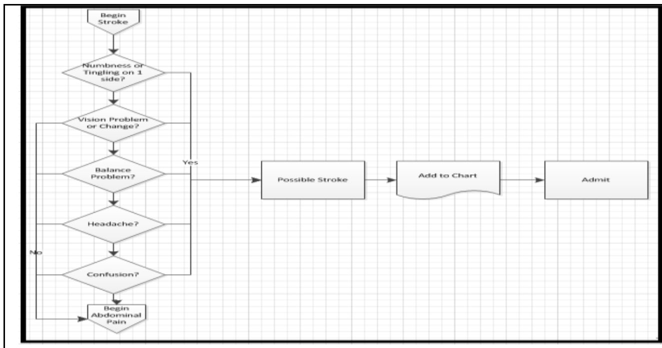

Figure 4 – Stroke Flow

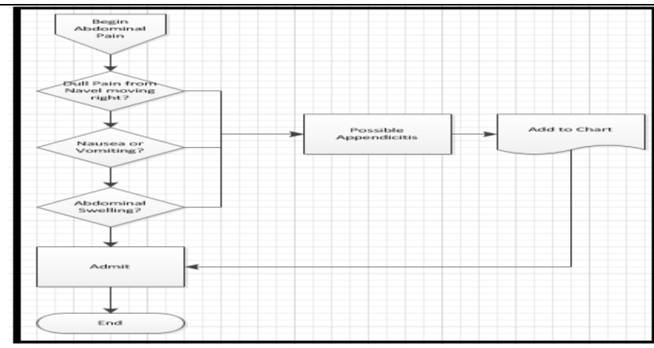

Figure 5 – Appendicitis Flow

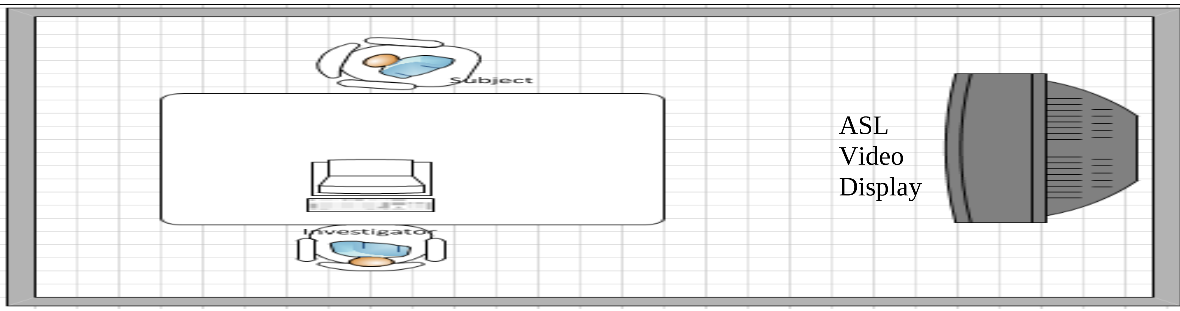

Figure 6 – Testing Facility

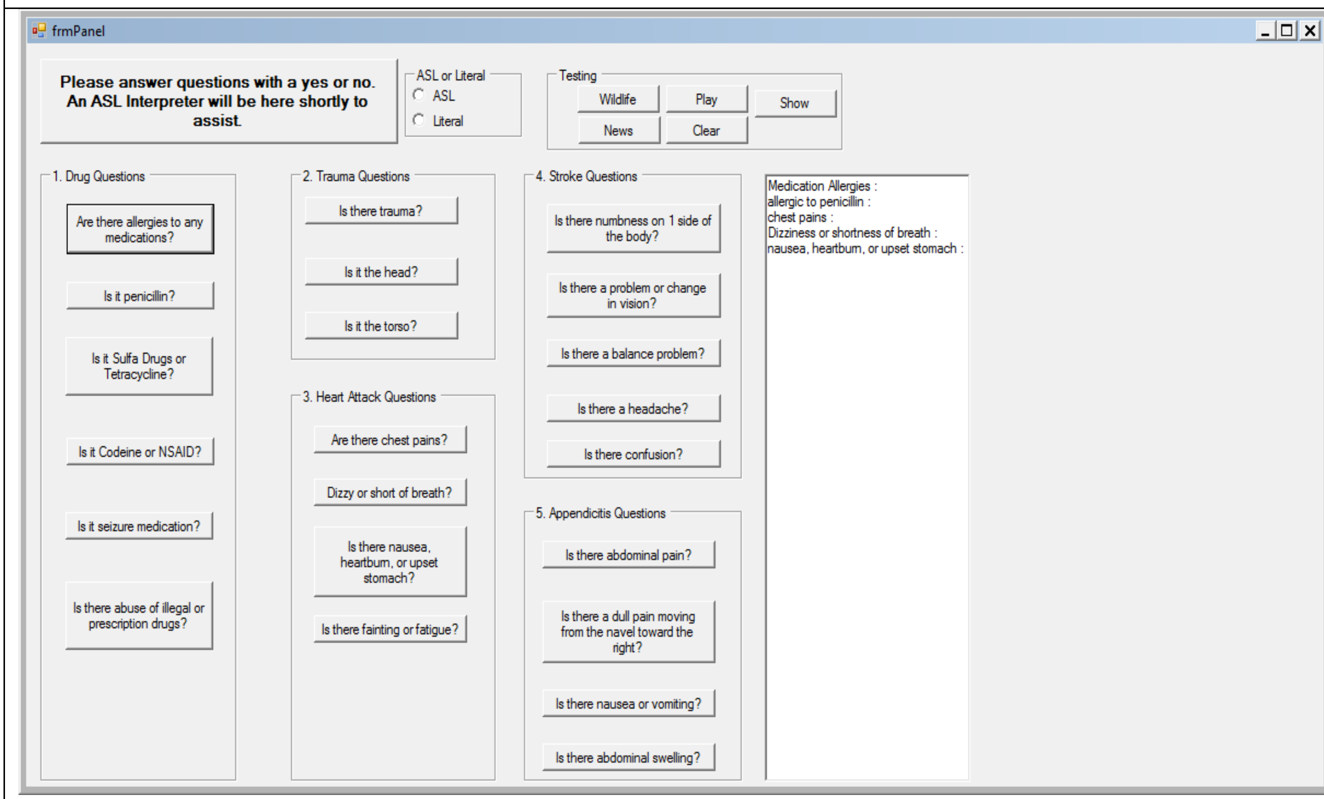

Figure 7 – Communication Board

CONCLUSIONS AND FUTURE DIRECTIONS

The purpose of this research is to provide preliminary research for a method to communicate with the deaf and hearing impaired in an emergency room scenario. The majority of research on communication facilities with the deaf and hearing impaired employs an avatar based approach; however, avatars are incapable of adequately communicating facial gestures which are a critical part of American Sign Language. This research overcomes this barrier by using human signed videos in order to convey facial queues. Preliminary testing demonstrates the method is effective in facilitating basic communication and extracting critical medical information.

Future directions include testing different types of deaf and hearing impaired such as those with minimal language skills (MLS) as well as increasing the number of subjects. Additionally, different dialects of ASL will be tested as well as a mechanism to determine the appropriate dialect for communication. The research will be extended to test the difference in comprehension between native sign language and literal interpretation between different levels of ASL speakers (i.e. native, second language, MLS). The flows of information must be further refined in conjunction with clinical personnel in order to model the information required in an emergency scenario in order to begin critical care as soon as possible. Finally, testing and design changes on the communication board and the hearing individual will be necessary to further refine the design and efficacy of communication.

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