Towards More Intelligent and Personalized AAC

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Abstract

Current augmentative and alternative communication (AAC) systems are relatively passive conduits for translating user intentions into spoken output. Users are expected to find and select icons that represent letters, words, or phrases to compose meaningful utterances without frustration, confusion, or errors. In reality, users often struggle to learn non-intuitive layouts, they make unintentional selections, they create telegraphic utterances, and many users end up abandoning their systems altogether. While some of these problems may be the result of social influences and acquiring a system relatively late in life, child users present their own unique challenges and opportunities. Our research focuses on the design and development of intelligent and personalized AAC systems that leverage natural language processing, machine learning, and contextual awareness to actively assist the user with communication and social interaction. We see AAC systems as active and familiar communication channels. This fundamental tenet has implications for both the design process and functionality requirements.

ACM Classification Keywords

H.1.2 [Models and Principles]: User/Machine Systems—*Human factors*; H.5.2 [Information Interfaces and Presentation]: User Interfaces—*Input devices and strategies*

Background and Motivation

The majority of augmentative and alternative communication (AAC) devices have interfaces that display graphemes or morphemes as buttons in hierarchical grids. Users activate these buttons sequentially, such as with a finger, switch, joystick, brainwave, or visual fixation, to create messages that can be spoken aloud via text-to-speech (TTS) engines. With recent advances in mobile technologies, many new AAC systems are being developed for use with touchscreen tablets; however, these touchscreen systems often have the same type of interface and behavior. For non-disabled users, touchscreens are designed to be highly sensitive and support multi-touch and gestures; for people with upper limb motor impairments, these same features are significant barriers to usage.

While older users often have difficulties adapting to new AAC systems, perhaps because they have become accustomed to communicating without technology, child users may be more receptive to and tolerant of new interfaces and technologies, such as touchscreens. Young AAC users present an opportunity to improve AAC interfaces and behaviors with user-guided designs and modifications. Additionally, new sensor and storage technologies now allow mobile devices to gather multidimensional data, increasing the possibility for creating more intelligent and personalized AAC systems that actively assist users in timely and meaningful communication.

Intelligent AAC

Drawing from the Intelligent User Interfaces (IUI) conference, we envision intelligent AAC systems to have some combination of the following three attributes:

- They are **user-specific**, meaning that they function differently, or can be customized extensively, for each user.
- They are **adaptive**, meaning that their behavior changes over time, perhaps as they learn the user's capabilities and preferences.
- They are **context-sensitive**, meaning that their behavior may change based on contextual cues, such as the user's location, the current time of day, or the specific task that the user is trying to accomplish.

Most AAC systems are user-specific, but only in that the vocabulary can be manually selected and relocated on the screen. Some AAC systems are adaptive in that they store the user's utterances and leverage statistical usage data for word or sentence completion. Very few AAC systems are context-sensitive, although some now allow users to group vocabulary items into categories based on location information from a Global Positioning System (GPS).

Our Work

To improve user-specificity and adaptivity, our laboratory is examining ways to accommodate the language and motor capabilities of individual AAC users by addressing assumptions made during the design and development of icon-based AAC systems. Many children use icon-based AAC systems because they are pre-literate or have developing literacy; however, these systems often make strong linguistic assumptions. Most icon-based AAC devices assume that activated icons were selected in a certain syntactic order and that the user selected exactly the set of desired icons, no more or less. There is evidence, however, that both of these assumptions are wrong: many users select items in unusual order, perhaps due to linguistic difficulties or to minimize physical movement. Users also unintentionally select additional items, perhaps due to tremors or spasms, or fewer items, perhaps to increase communication speed through telegraphic utterances. Although there has been some research in populating missing words, prior research has often avoided manipulating content words or has also assumed a certain syntactic order. We have developed approaches to address both of these problems simultaneously and have created a demonstration system called RSVP-iconCHAT, which is currently being integrated with a brain-computer interface (BCI) for use by people with locked-in syndrome [4].

Most icon-based AAC systems also assume that users will discretely activate each desired button, either physically or with a cursor. This assumption implies that only the selections are important, and the paths that the user made between selections are irrelevant. This assumption has been recently challenged by commercially successful text entry systems, such as Swype; however, these approaches have not been widely used in AAC, and lexical disambiguation does not translate directly to icon-based systems. We recently demonstrated how this approach can be adapted for use with semantic disambiguation [2] and built a prototype system, called SymbolPath, that is freely available from the Google Play Store [3]. We have also recently submitted evidence on the relative effectiveness of different contextual cues (e.g. location, date, and time) as language predictors for mobile devices; we will be integrating this work into future systems.

Finally, our laboratory has been developing methods for creating personalized voices that leverage the residual vocalizations of AAC users [1]. Most currently available AAC systems have a small set of generic voices. This lack of individuation has social implications and may limit the adoption of beneficial technologies. Our research offers the possibility that future AAC users will each have a unique voice of their own.

Workshop Contributions

We would bring to this workshop our experience in speech and natural language processing, motor speech disorders, machine learning, and artificial intelligence, as well as cooperative relationships with software developers and user communities, such as United Cerebral Palsy (UCP) and the Boston Home. We greatly value the opportunity to meet with other researchers in order to facilitate collaboration on grant applications, systems development, and user testing. Additionally, we would like to discuss the possibility of creating a shared, open-source AAC platform for rapid prototyping and testing of new approaches, as well as distribution to end users.

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