An Extensible Framework for Real-Time Conversational Avatars

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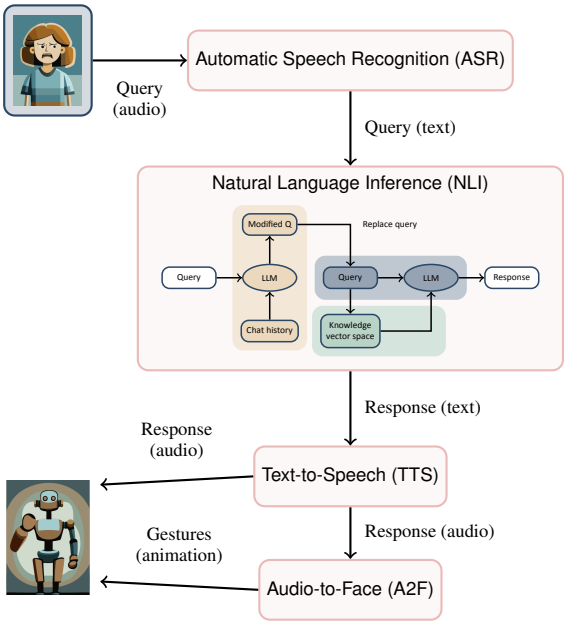
Abstract

The avatar framework is introduced to serve as a tool in simulation studies, or as a means of evaluating solutions for, e.g., automatic speech recognition or information processing in a larger context. It helps with prototyping and give a clearer understanding of the risks and opportunities associated with virtual agents.

A central goal of AI is to enable humans to interact with computers as naturally as they do with other people. The accomplishment of this aim requires comprehensive solutions to several challenging problems, including the automated processing and generation of speech, gestures, semantics, and pragmatics. As technology advances in these areas, avatars—essentially digital embodiments of chatbots—will become more integrated into our daily lives. It is believed that the additional modalities can enhance user experience, increase engagement, and lead to clearer communication. We are already seeing avatars being used in areas such as research,entertainment, gaming, education, healthcare, and marketing (Trepte and Reinecke, 2010; Kyrlitsias and Michael-Grigoriou, 2022).

Continued progress in the field requires a combination of competences, ranging form behavioural psychology to information retrieval and cloud computing. To lower the threshold for collaboration between research groups focusing on individual aspects of the problem, researchers linked to the Wallenberg Research Arena for Media and Language collaborate with the Ukrainan IT-company SoftServe to provide a transparent and extensible framework for real-time conversational avatars.

The schema on the right outlines the architecture of the avatar framework which is an end-to-end system enabling natural interaction between human and computer. The blocks labelled as ASR, TTS and A2F represent components which translate between modalities as follows. ASR is responsible for recognizing the audio input and transforming it to textual representation. TTS and A2F blocks both transform the textual response to an input query to audio and animation respectively. The block labelled as NLI denotes the LLM-driven processing units responsible for generating a textual response relevant to the input of the block (query in the architecture of the figure).



The framework consists of a base model (in blue) which together with a domain-specific knowledge component (in green) form the knowledge-based model. The can also be extended (in gold) to consider conversation history and contextual knowledge to provides more accurate and factual responses to the queries. The knowledge-based framework allows the avatar to be adapted practical use cases as it essentially implements retrieval augmented generation (Lewis et al., 2020; Karpukhin et al., 2020; Gao et al., 2024). Table 1 illustrates the result of providing the avatar with contextual knowledge in the case it is to be applied as a digital assistant to provide people with the information they need. The sample responses of the models indicates that the knowledge-based model generates

Query	Base Model	K.B Model
Who is the project manager of the arena?	The project is the person responsible for managing construction of the arena.	*Name* Project Manager, *Name* University, *Name* company.

Table 1: Comparing the responses of Base and knowledge-based (K.B) Models to the same input query, where proper names have been replaced by the label *Name*.

more accurate and factual response to the query as compared to the base model.

The value of the framework lies in the ease with which the existing components can be replaced, and new components added. For instance, to test the impact of new models on users for gesture generation, one simply changes between API calls of the models, leaving the remaining parts of the avatar untouched. Similarly, to understand the value of emotion-detection for naturalistic human-computer interaction, one can add a pre-processing step to generate a textual description of their emotion to be passed on to the NLI. The framework thus accelerates progress in the field by facilitating the evaluation of key technologies in a holistic setting.

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