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USING NATURAL LANGUAGE PROCESSING (NLP) FOR DESIGNING SOCIALLY INTELLIGENT ROBOTS

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Abstract – The design of natural interaction with social robots is highly complex process, given the huge design space of robots in terms of appearance and behavior and the challenges arising when using face detection and speech recognition in the wild. More natural and highly autonomous interaction is necessary to foster trust and engagement and hence establishing a long-term social relationship between users and robots. In this abstract, an adaptive and interactive dialogue system is designed to exchange a chat with a user using personal information stored in his/her user profile. NLP is used to extract user's basic information, hobbies and interests for building a rich user profile. The information from the user profile is used to customize and adapt subsequent dialogues in a way to build trust and initiate comfort between users themselves and the robot. The user profile is continuously updated whenever new information is extracted in subsequent dialogues. Face detection (FD) is used to identify the user. An artificial neural network (ANN) based FD system is used to increase the system's predictability. Failure to recognize a user's face leads to creating a new user profile for the new unidentified user. NLP failure leads to storing the whole sentence and manual fixing thereafter.

Index Terms – Human robot interaction, social robots, user modeling, user profile, long-term interaction, face detection, NLL, ANN

INTRODUCTION

Studies by the United Nations Economic Commission and International Federation of Robotics forecast a dramatic increase in consumer demand for robots that assist, protect, educate and entertain over the next 20–30 years [1]. It is expected that social robots tomorrow will be like personal computers today. In the future, personal robots will be able to help people as capable assistants in their daily activities. Socially intelligent robots could have a significant positive impact on real-world challenges, such as helping elders to live independently at home longer, serving as learning companions for children and enriching learning experiences through play, serving a therapeutic role to help children with autism learn communication skills, or functioning as effective members of human–robot teams for disaster response missions, construction tasks and more [1]-[3]. As robots progress from its traditional very controlled settings such as factories and laboratory environments and are deployed in homes and social contexts, the ability of robots to interact with humans in ways that resemble human interaction becomes more increasingly relevant [1], [3]. The ability of the robot to affect the user (mind and body) making the user respond and step-by-step feel more and more involved and engaged with the robot depends on the complexity of the interaction scenarios that can be supported. Many of these activities require the robot to learn new tasks, skills and individual preferences while '*on the job*'. This paper explores the idea of using NLP as a tool to help social robots to learn from natural interpersonal interactions with users, learn user's personal information and preferences and using this information to build a user profile which can be used subsequently to customize the dialogue system in a way to build trust and comfort between the user and the robot for deeper (long-term) relationship.

I. NLP for user modeling

NLP is used to help users to communicate with computers and robots in their terms and this is particularly important for casual users and those users who have neither time nor the inclination to learn new interaction skills such children and elderly people. The term Natural Language Processing encompasses a broad set of techniques for automated generation, manipulation and analysis of natural or human languages [5]. User modeling on the other hand is the subdivision of human-computer interaction that describes the process of building up and modifying a conceptual understanding of the user. A user model is the collection and categorization of personal data associated with a specific user. Therefore, it is the basis for any adaptive changes to the system's behavior. Which data is included in the model

depends on the purpose of the application. It can include personal information such as users' names and ages, their interests, their skills and knowledge, their goals and plans, their preferences and their dislikes or data about their behavior and their interactions with the system. There are different types of user models; static where there is no learning algorithm to alter it once it is collected and dynamic which allow more up to date representation of users where changes in their interests, learning progress or interactions with the system is noticed and used to influence the user models [6].

II. user modeling for long-term interaction

In this paper, a dialogue system is designed to collect basic personal data associated with the user such as names, age, profession, country, city and town, likes and dis-likes, hobbies and interests and store it in a user profile. User face picture is used to identify users using face detection and ANN and hereby retrieve the user's information stored in its user's profile. This information is subsequently used to customize future dialogues to foster long-term interaction by building trust and comfort. A schematic diagram of the proposed system is shown in Figure 1 where the user profile is continuously updated whenever new information is detected. When the robot starts a dialogue with a new user, it uses face detection to retrieve its user profile and use the information stored in that profile to customize the dialogue to give the user the feeling that the robot memories and care about him/her. If it failed to retrieve its user profile, it will create a new user profile for each new user.

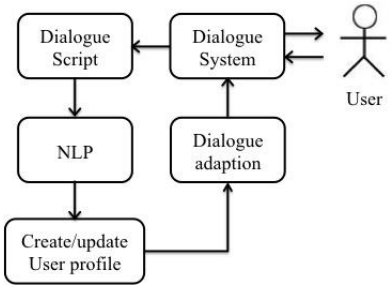

FIGURE 1. USING NLP FOR DYANMIC USER MODELING.

III. Experiment

The system platform is implemented using Python SDK and the code run on a remote computer connected to NAO robot. A python implementation of the Rapid Automatic Keyword Extraction (RAKE) and search for text functions are used to extract personal information and keywords. Face detection is implemented using NAO's NAOqi SDK pre-programmed functions developed by Omron that stories a list of angular coordinates for important facial features. An ANN is used to train features to increase accuracy especially when a user is facing NAO directly, under certain light conditions, or when the face is panned, rotated or tiled. A customized dialogue script to ask users about personal information is designed.

An experiment is carried out to assess the robots ability to extract personal information and use it to customize the dialogue system. The system was implemented using NAO robot and tested with 10 college students with age ranging from 20 to 30 years from both sex. In this first week, each student went into a dialogue with the robot. The dialogue script is used by NLP to extract basic information and keywords. Keywords are used to represent hobbies and are sorted according to its importance in the script. Each user face picture is used to create a user profile for a new user or retrieve/update an existing profile. In the second week, the system's ability to retrieve the information of each user from its user profile is tested where users are asked to grade how much relevant the stored information to them and how much they feel the robot knew them. 63.5% of the participants are satisfied about the system performance.

CONCLUSIONS

This study suggests the use of NLP to extract personal information, hobbies and interests associate with the user and use it to build a user profile for each new user or update a user profile of an old user whenever new information is extracted. The information from the user profile is used to customize and adapt the dialogue system to fulfill user needs, show empathy and friendship between the robot and the user to foster long-term interaction. As a future work, a similarity measure will be used to find connections between various user profiles stored in order to create a family or friendship tree and provide better understanding of the user.

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