# **Challenges and Opportunities for NLG in Persuasive Robotics**

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### ABSTRACT

Persuasion can be generally defined as the act of influencing each other with an attempt to change another's belief or behavior. Persuasive Robotics is the study of persuasion as it applies to Human-Robot Interaction (HRI). This article explores the challenges of designing Natural Language Generation(NLG) for persuasion robotics. This current work in progress will focus on a multimodal emotional persuasion system. We use a humanoid Nao robot to persuade a human subject to donate to a charitable cause. The Nao robot reads the human's facial expressions and gaze to adapt the robot's appeal for charity by changing it's verbal and non-verbal cues according to the recognized facial expression. This work provides opportunities for an NLG model to explore an interactive, multimodal HRI setting.

# **CCS CONCEPTS**

 $\bullet \ Computing \ methodologies \rightarrow Natural \ language$ 

generation; • Computer systems organization  $\rightarrow$  *Evolutionary robotics*; Robotic autonomy.

### **KEYWORDS**

emotional persuasion system, multimodal NLG, persuasion robotics, Human-Robot-Interaction

## **1** INTRODUCTION

Social robots are envisioned to use human language to assist people with informational needs in places such as museums, shops and information booths. Humanoid robots are well suited to such roles due to their intuitive interactions, embodiment and ability to use human communicative mechanisms. People tend to react socially and get influenced differently when interacting with an embodied humanoid robot. A physically embodied social agent can go beyond just providing information to actually persuading listeners to make certain choices similar to an effective human speaker. Seiter and Gass [4] writes that "the most common human enterprise is, by and large, influencing other people". A large part in almost every human interaction is attempting to change one's own, as well as others' beliefs and behavior, thus a truly social robot would have to incorporate this type of behavior into its core social intelligence.

Appropriate persuasiveness, designed to benefit people and improve interaction, has far-reaching practical implications in HRI. We must consider exploring NLG techniques instead of hard-coded linguistic outputs for HRI especially in persuasion robotics. In the next sections of the article, we describe the setup of our experiment of our current work in-progress and the possible challenges of applying an NLG model to this study and conclude with opportunities for future NLG models in persuasion robotics. Joanne Dugan jbd@virginia.edu University of Virginia Charlottesville, Virginia

### 2 EXPERIMENTAL SETUP

We developed an emotion recognition framework for Nao robot which makes an intelligent guess of human subject's emotion by reading their facial expressions and gaze. This framework provides a standard means of modifying robot behaviour in response to emotional state. The Nao robot's internal emotion state determines the robot behavior such as body movements, gestures and posture, changing color and blinking of eye LEDs, changing the pitch and tone of the robot's voice and other verbal cues. This adaptation of robot behavior to accommodate social interaction with human subjects is a good opportunity to step away from simple hard coded sentences for verbal interaction and focus more on using NLG to determine the affective language for verbal persuasion.

#### 2.1 Procedure

Our current work's procedure has been inspired by Siegel et al. [6] and improved by adding emotion recognition in the model and performing pilot studies in our previous work [5]. We recruit participants to interact with a Nao robot with a promise of 5 USD as compensation for participation. This compensation is paid in 5 single dollar notes/bills at the beginning of the study and asked to complete a pre-test survey questionnaire before they meet the robot. The participants then enter the room to interact with the robot where the robot does an educational performance and a persuasive appeal. The first part consists of robot providing a brief explanation of its hardware and software systems and a general overview of its technical capabilities. This included a short discussion of its sensors and how they relate to human senses. The second part consists of the robot presenting a persuasive appeal arguing that "It has become increasingly difficult for students to reconcile the rising costs of tuition, and living expenses while earning a degree, and thus many students find themselves having to choose between affording the cost of college and purchasing daily essentials, such as food". The appeal ends with a donation request to the University's Community Food Pantry to support fellow students who may be facing food insecurity. The robot asks to place the donation (in dollar bills) in the donation box while saying "Any money you have left is yours to keep" and requests the participant to fill out the post test survey questionnaire. The measure of persuasion is the amount each participant donates out of 5 USD.

#### **3 NATURAL LANGUAGE GENERATION (NLG)**

NLG is the branch of natural language processing that deals with the automatic production of texts in human languages, often starting from non-linguistic input [3]. The three-stage model proposed in Reiter and Dale (2000) [3] is usually taken as a reference:

- (1) Document planning that decides the content and the structure of the message to be generated (sometimes called strategic planning).
- (2) Microplanning that decides how information structure should be expressed linguistically, involving mainly lexical choice.
- (3) Surface realization that generates the final output according to the decisions of the previous stages and according to, for example, grammatical and anaphoric constraints (sometimes called tactical planning).

## 3.1 Application

Most systems and approaches in NLG are based on descriptive tasks, focusing on texts which realize a single, often informative, communicative goal, as opposed to persuasive NLG where the communicative goal is usually surmounted by reasoning about the persuadee's behavior modification. Two NLG approaches could be identified for this study: Monological Persuasion and Dialogical Persuasion.

While the three stages of planning as mentioned in section 3 apply to monological persuasion, in "pure" persuasion dialogues, the sequence of exchanges includes some typical phases, and forms of reasoning, by the persuader such as: Making a proposal; Observe the persuadee's reaction; classify it; reason again; and justify it [2].

## 4 CHALLENGES

In this section a list of challenges which could possibly be taken into consideration to build an effective persuasive NLG is presented.

#### 4.1 Knowledge Representation

To simulate natural argumentation and (emotional) persuasion, it is necessary to define new methods for representing knowledge, for reasoning on it, and for generating natural language and multimodal messages. A framework is needed to formalize them, by representing the various sources of uncertainty and incomplete knowledge including emotional responses from the user. Other related aspects such as critical questions, counter-arguments must be taken into consideration.

#### 4.2 Measures needed in persuasion

The strength of persuasion strategies must be measured to handle the problem of uncertainty, to model the concept of effectiveness of a message, to choose the best strategy to be used at every interaction, and also emotional impact of a message. This measure should be used as an effective feedback to the humanoid robot to adapt its persuasive appeal.

#### 4.3 User Modeling

For effective communication, customized messages are needed. To prepare these customized messages, detailed user models are necessary depending on the kind of interaction model. Static user model for monological interaction and dynamic user model for dialogical interactions. Customized messages from Generative Pre-trained Transformer-3 [1] show most promise

#### 4.4 Emotion manipulation

A model to choose the best persuasive move the system can make in a given situation is necessary to make an effective emotional appeal. The overall intention of the interaction must be considered in the model. Boundaries of manipulation in the appeal must be included in this model.

#### 4.5 Multi modality

Multimodal communication such as the use of gestures, sounds, eye movements play a role in persuasion. Nao robot can be best utilized for multimodal communication through its use of eye LEDs, ear LEDs, speakers to play audio files along with speech, robot body language, gestures and actions could be combined to persuade effectively.

## 4.6 Evaluation

All variables that can affect the effectiveness of the system must be observed in correlation to context of use, scenario of the interaction, required task, persuasion strategies available and so on. Specific evaluation methodologies must be defined. Evaluation of the robot's appeal must be done accordingly, periodic or at the end of certain key persuasive sentences, so that the robot can use it as feedback to adapt its appeal.

#### 4.7 Indirect Aspects

Attention and memorization of the persuadee can affect the effectiveness of persuasive messages. If the user's attention is low, the humanoid robot must grab their attention by focusing on the key concepts that the robot wants to persuade on. Other aspects such as political correctness, irony and sarcasm must also be considered. Attaching the persuasive appeal to a cause affected by something that everyone is affected by, such as the COVID-19 pandemic, has a stronger impact. Therefore external influence of the appeal must also be considered.

#### 4.8 Ethical Reasoning

As robots become complex social agents, common in our daily lives, the need for ethical design for such agents is becoming more compelling. A set of principled guidelines for design and implementation of ethical persuasive agents is necessary. At what point does the persuasion cross over from being appropriate to infringing on human rights, values and trust?

### 5 CONCLUSION

These challenges are strictly interconnected; modeling decisions of one aspect often have consequences on other aspects. A multimodal emotional persuasive system must take into account the specifics about the user, such as needs, interests, and knowledge; in particular, we think that the emotion dimension and the personality dimension must have a part in individual-oriented and contextaware communication systems. Modeling persuasion mechanisms and performing flexible and context-dependent persuasive actions are ambitious especially in HRI studies involving persuasion robotics. Recognizing these challenges for would be a good step for persuasion robotics. Challenges and Opportunities for NLG in Persuasive Robotics

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