

Paper:

# Behavior Generation and Evaluation of Negotiation Agent Based on Negotiation Dialogue Instances

Daisuke Katagami\*, Yusuke Ikeda\*\*, and Katsumi Nitta\*\*

\*Department of Applied Computer Science, Faculty of Engineering, Tokyo Polytechnic University  
1583 Iiyama, Atsugi, Kanagawa 243-0297, Japan  
E-mail: katagami@cs.t-kougei.ac.jp

\*\*Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology  
4259 Nagatsuta, Midori-ku, Yokohama, Kanagawa 226-8502, Japan  
E-mail: ikeda@ntt.dis.titech.ac.jp, nitta@dis.titech.ac.jp

[Received April 18, 2010; accepted August 8, 2010]

**This study focuses on gestures negotiation dialogs. Analyzing the situation/gesture relationship, we suggest how to enable agents to conduct adequate human-like gestures and evaluated whether an agent's gestures could give an impression similar to those by a human being. We collected negotiation dialogs to study common human gestures. We studied gesture frequency in different situations and extracted gestures with high frequency, making an agent gesture module based on the number of characteristics. Using a questionnaire, we evaluated the impressions of gestures by human users and agents, confirming that the agent expresses the same state of mind as the human being by generating an adequately human-like gesture.**

**Keywords:** negotiation dialog, negotiation agent, gesture generation

## 1. Introduction

Negotiation is the process in which individuals and groups reach agreement on how to solve problems ranging from international conflicts, professional-athlete contracts, and product purchase discounts to where to eat dinner or what to watch on TV. Negotiations depend on mutual interdependence, making it important to maximize negotiation skills to reflect one's views while maintaining good relationships with others. Psychological studies have pointed out the importance of nonverbal communication such as behavior. Actual negotiation situations may change due to personal factors such as the feelings of the negotiating parties themselves or attitudes among negotiating counterparts [1]. Negotiations thus must communicate more than just utility values, including the implementation of nonverbal information.

Our research on online negotiation support [2–7] has focused mainly on utterance generation, not on agent behavior. Negotiation support studies [2] generally involving 3 types of behavior – pounding on a desktop, folding one's arms, and raising the hands – are selected and nego-

tiation support [7] using eight types of behavior – raising the hands, waving the hands, shaking hands, beating, folding one's arms, pumping fists, hand beckoning, and booing – are conveyed using a Wii controller. Because behavior options are produced by system designers, however, behavior actually required in actual negotiations may be lacking and unwanted behavior included due to a lack of knowledge on truly really appropriate negotiation support behavior by such system designers.

This study observes human behavior during actual negotiations, implements behavior in an agent based on feature amount of behavior, compares agent-generated behavior impressions and those by human, and verifies the effectiveness of the generated behavior.

In this article, Section 2 outlines studies related to negotiation support systems and points out current problems, introducing studies on the importance of behavior and analyzing multimodal information, actively studied mainly in multiparty interaction [8] in observing human behavior. Section 3 discusses negotiation dialogues and analysis. Section 4 tells how the system is implemented in agents. Section 5 evaluates experimental results reviewing and confirming the effectiveness of generated behavior. Section 6 presents conclusions.

## 2. Related Studies

To overcome problems in existing studies on negotiation support systems related to our study, we introduce psychological studies on how human behavior affects counterparts. We also discuss multimodal analysis observing actual human behavior, and define gestures as intentional acts and behavior as acts including unintentional ones in addition to gestures.

### 2.1. Negotiation Support System Studies and Problems

Negotiation support studies include online negotiation support systems involving computer networks in which negotiators exchange proposals and opinions through client-servers.

Online negotiation studies include network negotiation tools, e.g., negotiation systems and protocols [9–11], theoretical studies on optimum proposals through game theory [12, 13], and negotiation models of counterparts [14]. Some studies design systems to automatically negotiate on behalf of users and others support negotiations presenting users with appropriate or optimum information, e.g., Graphic User Interface (GUI) tools to exchange proposals, prices, product information, and utility values, including InterNEG [9–11].

Some systems convey nonverbal information to counterparts through animated facial expressions and gestures using online negotiation support [2] enabling users to select 5 types of facial expression – laid-back, happy, angry, sad, surprised – and 3 types of behavior – pounding on a desktop, folding one’s arms, and raising the hands – from an interface menu. Other systems [7] enable users to receive push-button signals and acceleration data from a Wii controller helping them select facial expression and discriminate among types of behavior – raising the hands, waving the hands, shaking hands, beating, folding one’s arms, pumping fists, hand beckoning, and booing. Such behavior is, however, often prepared by designers assuming that those are frequently used in negotiations. This accordingly causes a lack of necessary behaviors the users want to use or presence of unnecessary behaviors when the users actually use the systems to negotiate. As known from them, the existing negotiation support systems have placed more emphasis on studies of logical utterance generation and analyses and not well evaluated importance of behaviors in negotiations.

## 2.2. Psychological Studies on Behavior

An experiment by Mehrabian [15] showed that messages with inconsistent feelings and attitudes were conveyed to human beings through verbal information such as speech in 7% of the cases, through audio information such as tone of voice and utterance speed in 38% of the cases, and through visual information such as physical appearance in 55% of the cases. They found that when a sender sent an ambiguous message while communicating attitudes and positive and ill feelings, the receiver of the message attached more value to tone of voice and body language than to verbal content. Negotiations generally include tactics to change situations to the negotiator’s advantage, so responses do not always reflect actual thinking or feeling. This means that discrepancies are likely to arise in verbal and nonverbal communication than in ordinary dialogue. Given the many similar situations in Mehrabian’s experimental setting, it is important to generate appropriate behavior when designing agents engaging in negotiations.

Human communication explicitly conveys meaning through verbal information typified by utterances, but other information, i.e., nonverbal communication such as facial expression, eye contact, and gestures, is also important [16]. Nonverbal information both works as a secondary factor in simple expressions of feeling and also

affects the understanding of the meaning of an utterance, e.g., a speaker’s gestures affect the accuracy and understanding of utterances [17]. Speaking accompanied by gestures doubles the accuracy of understanding over that of a simple spoken – i.e., gesture-free – presentation [18]. Experiments have confirmed that stimuli with gestures are understood better than mouth movement and facial expression [17].

## 2.3. Studies on Multimodal Analysis

Multiparty interaction studies interpret structures with multiparty behavior-chain over time. Behavior over time includes words and sentences serving as main topics of linguistic studies, and body actions such as gestures and eye contact, whose start and end are easily determined. Segmental units obtained by delimiting behavioral factors, mainly along time axes, are called analysis units. Linguistic studies typically handling words and sentences have attempted to maximize the segmentation of verbal expression and interaction using 2 types of analysis: the first is chain structure analysis of interaction analyzing relationships between utterances by multiple persons in real-world interaction and relationships between specific utterances and their spoken contexts. The second type of analysis, integration structure analysis of multimodality, analyzes synchronization between multiple behavioral factors with different modalities such as utterances and gestures and synergistic effects arising from the cooccurrence of behavioral factors. These analyses require meaningful behavior in interaction specified as units and the occurrence of individual behavioral factors plotted along time axes. In integration structure analysis, Kendon [19], defines the integration of 2 types of modality – utterance content and accompanying gestures – as “utterance” in gesture studies. Our study uses Kendon’s definition in analyzing utterances in negotiation and behavior triggered by “feelings” in utterances.

## 3. Negotiation Dialogue Collection and Analysis

### 3.1. Overview

To develop an agent that behaves based on feelings triggered by utterance content and negotiation situations, we collect human negotiation dialogues and study the correspondence relationship between the situation and behavior in negotiations. We discuss the collection of negotiation dialogues to study human behavior used to design agents and how to analyze collected data (**Fig. 1**). We first collect negotiation dialogues to study human behavior type and frequency in negotiations. Collected instances consist of voice and image data. We then annotate the amount of feature in negotiation based on collected data and create an instance database. The instance database includes utterance logs, utterance situations, and behavior features. We use this data to study behavior