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Socially-Competent Computing Implementing Social Sensor Design

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ABSTRACT

The paper presents a conceptual model for social sensor design in socially-competent computing systems. The model is based on theories of social behavior being driven by the underlying attitudes, rather than on models predicting behavior in response to behavior representing people as physical objects in dynamic interactions. It is proposed to increase the ability of the systems to extract relevant features and to achieve better social competence, similar to the kind that is underlying human interactions by implementing algorithms, capable of predicting behavior in response to attitude. The paper presents an account of the social level of understanding human interactions in the context of three application scenarios – multi-hop communication networks, embedded systems for support of medical interventions and information systems supporting educational activities. Patterns of real data are discussed in terms of the proposed model of social sensor design for enhanced socially-competent computing.

Keywords: *Attitudes, Personality Filter Design, Personality Theory, Social Sensors, Socially-Competent Computing Systems*

INTRODUCTION

Modern information systems for recording people and their interactions (e.g. surveillance systems, mobile communication networks, social robots) collect enormous amount of data which is being processed in time and effort consuming way, yet far from being sufficiently competent to be reliable in performance. Most computing algorithms aim at modeling people as *physical objects* in dynamic interactions. To achieve better social competence computing systems need to be able to identify the underlying processes guiding human interactions by extracting relevant features for the respective cognitive level of analysis of the perceived information. Apart from identifying other people as physical objects, human perception is capable of identifying signifiers of *social signals* as well as *psychological features* that are necessary for adapting to life in the society (Forsyth, 1990).

In the current paper it is proposed to distinguish three levels of cognitive analysis of the observed human behavior. If our system is capable of predicting behavior in response to behavior, it operates on the *physical level* of

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description of the observed situations. In human society people make predictions of other peoples' behaviors in response to social and psychological *drives* like *attitudes* and *opinions*, rather than simply responding to the observed *physical* drives. If the computing system is capable of predicting behavior in response to attitudes – then it operates on the *social level* of description of the observed behavior. Whenever people describe other people's behavior as opinion-driven – then they provide interpretation on the *psychological level* of description of the observed behavior. The main claims in the current paper are that: a) it is completely possible to increase system intelligence to the level of *social interaction* understanding by making it capable of *predicting behavior in response to attitude*; b) at present it is important to make the *socially competent* computing system adapted to functioning in social situations and capable of introducing structure to various social situations like technology-mediated education (Dimitrova, 2008, Dimitrova & Wagatsuma, 2011, Young et al., 2011), social robotics (Barakova & Lorens, 2010, Barakova & Vanderelst, 2011), smart environments (Deleawe et al., 2010), hospital surveillance systems (Casale et al., 2011) and others. At the same time this is not the case with the efforts to make the computing system *psychologically competent* in terms of predicting behavior in response to *opinion*, which is both problematic and, probably, often irrelevant (e.g. Sharkey, 2008). The main focus of the current paper, therefore, is the ability of a computing system to operate on the *social level* of description of a situation by reading of the relevant cues by especially designed sensors, called *social sensors* in a way similar to people reading social cues. It will be shown that the task of designing technical systems/devices capable of predicting behavior in response to attitude is a completely achievable present-day task.

Most of the current approaches to *social sensor* design apply the analogy with pattern recognition theories or image processing methodology. The main indicators of the social nature of the object – the human – are the signifiers of social interaction and social signaling – voice intonation, hand gestures, flow of speech, posture, facial expression, etc. (Pentland, 2007, Pan et al., 2010). The main approach to modeling the nature of the interaction is based on collecting sets of features and classifying behavioral patterns, belonging to different social situations (Hernandes et al., 2010, Kim et al., 2010). Sequences of behaviors are modeled via Hidden Markov Models (Pan et al., 2010), Gaussian Mixture Models (Hernandes et al., 2010), Conditional Random Field (Kim et al., 2010), Laban movement theory (Lourens et al., 2010), F-formations (Hung & Krose, 2011), T-patterns (Magnusson, 2000, Jonsson, 2006) and other machine learning approaches. Considering that as physical objects people are more flexible in behavior and of changing appearances, it is not surprising that applying simply the developed techniques for object and pattern recognition in other domains is insufficient for diagnosing *social presence* in a situation. Therefore current systems are capable of predicting behavior in response to behavior based on modeling people as physical objects in dynamic interactions. It is urgently needed to increase the ability of the systems to extract relevant features and to achieve better social competence, similar to the kind that is underlying human interactions. This will allow developing algorithms for predicting the outcomes of social interactions – whether conflict or consensus will result - from reading behavioral patterns in different modalities – visual (facial expressions, gestures), auditory (prosody), tactile (clash) organized in unambiguous sets of features.

The socially-competent computing systems are intended to perform on both levels of abstraction of the cognitively processed information – to define human behaviors, responding to other people's behavior (basic level of system cognitive performance) and to define human behaviors, responding to other people's attitudes (abstract level of system cognitive performance). Whereas most effort is directed towards implementing intelligent systems, performing reliably on the basic level, socially competent systems can achieve more flexible performance if they are capable of defining behaviors, responding to other people's attitudes. The rest of the paper is organized in three sec-

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