Culturally Adaptive Mobile Agent Dialogue to Communicate with People in Crisis Recovery

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ABSTRACT
We present ongoing research concerning the interaction between users and environmental agencies through autonomous mobile agents in the environmental monitoring domain. The overarching EU FP7 project DIADEM, concerns the development of a system that detects potentially hazardous situations in populated areas using input from both a distributed sensor network and humans through their mobile devices. We propose a model of interaction with a system where concerned citizens communicate with a social virtual agent through their mobile phone to inform the environmental monitoring agency about unusual smells. In case of an emergency, people will receive instructions or directions for evacuation from the agent. In this paper, we review relevant literature and describe the development of a dynamic dialogue agent that supports international collaboration by adapting its social interaction to the cultural background of the humans it interacts with.

Keywords
Culturally diverse users, human-agent dialogue, crisis recovery

INTRODUCTION
Location and context-aware mobile services are expected to adapt to users' needs and tailor information to a specific situation. These services can also collect information from the user at specific locations; especially when information cannot be gathered in other ways or when human assessment (rather than automatic processing) is necessary. This can be highly useful for emergency services in crisis situations [31]. In this paper we propose an environmental monitoring system that interacts with members of the general public in crisis contexts (specifically, environmental monitoring). People may experience strong emotions and stress, reducing their ability to provide reliable information or follow the instructions that the system offers. In contrast, the environmental monitoring agency workers are highly dependent on reliable observations from the public because the sensor systems can only detect an anomaly and they can only make a limited set of expert observations (figure 1) themselves.

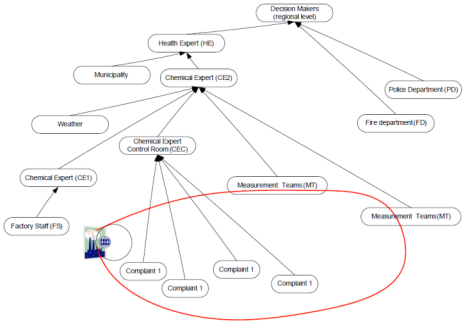

Figure 2: Collaborative structure environmental management

The detection system [27] then starts generating hypotheses based on the wind direction and possible sources of pollution (factories, harbours). By combining the observations reported by human observers, a more precise spread of the pollution and description of the pollutant can be determined (see figure 2). Once the nature of the pollution, the cause, the location and the spread has been determined, the government or crisis response team can instruct the public by sending location specific messages to their mobile phones.

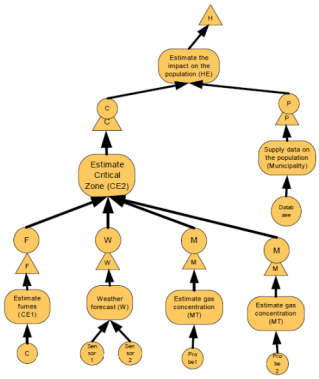

Figure 2: the configuration of workflows to support processing by humans and systems.

The mobile agent therefore supports the collaboration between the environmental agency and the public on

multiple levels. It facilitates the combination of knowledge of many members of the public as well as their efficient evacuation if needed and allows the crisis response team to communicate with the public in an efficient manner. The project considers environmental events on a local scale such as a gas spill in an urban industrial area but also on an international scale such as a gas cloud that threatens multiple countries as it is transported by wind. Therefore, the system will need to consider human responses from and instructing people with various cultural backgrounds.

If semi-autonomous location aware crisis response systems contact people via their mobile phones on behalf of emergency services in crisis situations or during an environmental incident, it is important to understand the ways in which people from different cultural backgrounds will respond to agent requests and instructions. The reminder of this paper describes our efforts in extending the DIADEM detection system's dynamic dialogue agent to adapt to user's cultural background to interrupt, request information from and instruct humans.

THEORY

The system described in this paper heavily depends on users responding and providing reliable information. It is likely that cultural background influences people's general attitudes toward autonomous agents or mobile technology in general. In Europe, mobile phone penetration for instance, is higher in Germany (128.27 subscriptions per 100 inhabitants) and Portugal (139.64) than in France (93.45) or Latvia (98.90). These rates are higher than the US (86.79) and much higher than the developing world, for instance China (47.95) and India (29.26) [21]. Also, from previous research we know that people respond differently to what is seen as socially normative agent behaviour in a particular culture. People from different cultural backgrounds are more likely to comply to agents that are seen as an in-group member [9] and are more likely to change their decision to that of the agent when it communicates in a socially normative way (i.e. implicit communication for Chinese users and explicit for US users) [30]. Therefore, what people may find 'trustworthy' or 'credible' behaviour may vary considerably across cultures. For the purpose of our research and in line with cultural research [14,16], we will call these inherent beliefs *cultural values*. Local factors such as the nature of the event which could depend on the type of industry common in a country can be seen as *cultural context* when they represent institutions or processes that are common in a given culture (such as the type of industry or judicial structures) and as *local context* when they are specific for the locale but less strongly intertwined with cultural values (for instance the topography of an area that will influence the spread of a gas cloud).

Dealing with interruption

The DIADEM agent will interrupt people to request information or issue instructions on behalf of governments or crisis response teams. The first goal of our research is to design the human-agent dialogue in order to minimize the negative effects of such interruptions. Since hazardous pollution events seldom happen, the system will more often request information from the public to monitor acceptable levels of gasses rather than give emergency instructions. System interruptions can cause feelings of frustration, distraction, and increase the time required to perform the primary task [24]. McFarlane and Latorella [25] showed that unpredictable and uncontrollable interruptions induce *stress,* negatively affect performance, cause people to make mistakes, reduce efficiency. Iqbal and Bailey [19] reported elevated annoyance and anxiety, increased error rate, and decreased performance and decision making. Other studies found negative effects of interruptions on memory [6] and that users lose considerable time when having to switch between tasks [20]. According to Clark [4], people normally negotiate human-human interruptions. Social conventions dictate the most appropriate time for one person to interrupt another [15]. However, determining when to interrupt users is much more challenging for services or applications. In contrast to humans, these applications cannot simply utilize long- established knowledge about social conventions.

Table 1. Negative effects of (task interruptions and human- as well as system strategies to mitigate these negative effects.

Negative effects (on)	Human strategies to mitigate disruption	System strategies to mitigate disruption
• Task resumption lag and task related memory loss [19, 20], • Emotional state (e.g. annoyance, anxiety) [25, 1], • Task performance [1].	• Negotiate time of interruption [4], • Use knowledge about socially acceptable times to interrupt [15] • Social behavioural strategies, empathy, politeness, praise [2]	• Assess appropriate time to interrupt (late, at breakpoint, at low cognitive workload) [25, 19, 20, 1], • Offer visual cues [6], • Rehearse task [18], • Negotiate interruption [4].

As can be seen from Table 1, current system strategies focus on knowing *when* to interrupt, help users recover *after* interruption and *negotiate* interruptions. Humans, however, use a variety of social strategies to *mitigate* interruptions, such as expressing a request for interruption with politeness or empathy, or interrupting with certain nonverbal behaviours. Brown and Levinson [2] argue that interruption is a kind of communication act (a face-threatening act), and that the way the interruption is expressed (i.e., the deliberative decision on how to construct the message) determines its effect on social relationships. We expect that mobile agents that interrupt users with location-dependent information or requests will be able to similarly mitigate the negative effects of interruptions by adopting comparable human social behaviours. However, we argue that ways of mitigating the negative effect of face-threatening utterances in dialogue are culturally dependent. For instance, Holtgraves and Joong-Nam [17] found that Brown and Levinson's face-saving theory was useful in cross-cultural evaluation of

face-saving behaviours. They found that the relationship between power, distance, and politeness was indeed the same for Americans and Koreans. The theory further predicted that power and distance should combine additively to affect the perceived likelihood of different request strategies. Instead, Holtgraves and Joong-Nam found that power had the predicted effect only for a distant relationship, and relationship distance had the predicted effect only when power was equal. Jenny and Horst [22] state in their overview paper that findings of individual politeness studies tend to underscore the cultural relativity of politeness phenomena. Partly for this reason the standard politeness theory has been criticized increasingly for having a Western ethnocentric bias. In our research, we aim to develop a dynamic social dialogue agent that will adopt face safe responses that are appropriate for the cultural background of the user it interacts with. In order to program the dynamic dialogue system with possible polite dialogue behaviour, we will first run cross-cultural socio-psychological experiments to evaluate which face-save and politeness strategies mitigate the negative effects of interruptions.

Motivating members of the public

The most basic distinction between motivation types is between intrinsic motivation, which refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivations, which refers to doing something because it leads to a separable outcome [7]. We will focus on increasing intrinsic motivation because people who live in monitored areas act in their own interest (and that of their community). The literature proposes several strategies for increasing motivation.

Altruism A review of studies (e.g., [29]) focusing on volunteer motivations for participation in environmental stewardship activities revealed that helping the environment was most often mentioned as the initial motivation for volunteering [12]. Studies on volunteers in social services [5] showed that one of the most often mentioned motivations is doing something worthwhile.

Praise Interpersonal communication research demonstrates that praise increases a person's intrinsic motivation and also increases the amount of time and attention the person devotes to the task [3]. However, [13] argue that praise only works really well as a motivation if it is accompanied by social comparisons.

Social comparison Festinger [10] proposed that a motivation to evaluate one's own achievements and opinions drives people to rely on social-comparison information, Nicholls [26] highlights the positive effect of social comparison on intrinsic motivation.

Reeves and Nass (e.g., [28]), have provided substantial evidence for people responding socially to computers and other media and applying similar social rules and expectations to human-computer interactions than they do to human-human interactions. Fogg and Nass [11], for instance, showed that the effects of flattery from a computer can produce the same general effect as flattery from humans. Thus, we assume that using motivational feedback will lead to similar positive effects in the interactions between users and the mobile agent. However, [23] did a study on altruism in 6 countries and found that mean scores on the three altruism measures differed significantly across samples. Also, Earley [8] examined the usefulness of feedback on behaviour across cultures and found that American and English workers valued and responded to praise and criticism differently. Similarly, we expect that different social motivational strategies are needed to motivate people from different cultural backgrounds to optimize responsiveness and reliability of the information they provide. The DIADEM dialogue system will therefore need to dynamically adapt its social dialogue to motivational strategies that are appropriate to the users cultural background.

CONCLUSION

We believe that universal design for social agents does note exist and propose a cultural approach to developing an adaptive social agent as the public interface to an autonomous gas detection system to support collaboration between national and international environmental agencies and members of the public. We will focus our efforts on an area that encompasses the Netherlands, Germany, Belgium, Denmark and Portugal. First, we will run socio-psychological experiments that are controlled but 'in the wild' to determine what agent social behaviours will mitigate interruptions and motivate people for the different cultural backgrounds involved. Secondly, we will develop a new version of the DIADEM agent that will contact users through their mobile phone. This culturally adaptive agent will adapt its dialogue style to the national location of the user and what is known of the user's profile to select culturally appropriate social dialogue behaviours in its interaction with the user. Through post analysis after an event, the system will use the information received from users to assess responsiveness and reliability for each of the social behaviours displayed. From this learning set, the system will learn which behaviours yield the most reliable responses for the particular cultural group. Over time, the DIADEM system will learn to adapt it's social dialogue to the cultural background of the user and in the mean time collect valuable usage data on responsiveness and accuracy of reports for the different social communication strategies to extent cross-cultural research in this field.

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