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The PASION Project: Psychologically Augmented Social Interaction Over Networks

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ABSTRACT

Ever more frequently, social and particularly group interactions, involve mediated communication. Yet we know very little about the factors determining the effectiveness of the interaction. How do participants in mediated communication substitute the implicit, and non verbal signals which play such an important role in traditional, face to face communication? What are the equivalent signals in a mediated environment? The mechanisms involved in traditional communication are well-known. By contrast, very little is known about the forms of mediated communication. For instance, we do not know the role of implicit and non-verbal communication when the communication takes place in a mediated environment. PASION's working hypothesis is that in mediated environments these messages will take completely new forms and that these forms are due to group interactions in technology-mediated environments. As current communication technologies are ineffective in conveying the social, non-verbal and contextual information required for effective communication, PASION will deliver an innovative shared virtual environment where a pioneering mediated social communication will take place.

Keywords: *social presence, mediated social interaction, shared virtual environments, non-verbal and contextual information.*

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1. Introduction

The PASION Integrated Project has been funded on under the Presence II Initiative in the Future Emerging Technologies within the 6th Framework Programme (more information available on http://cordis.europa.eu/ist/fet/pr.htm). The project, which will last 4 years, defines an ambitious research program and has the potential to

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significantly advance the state-of-the-art in basic research, technology development and applications. As the project has just started the paper will focus on the description of the vision, research program, and the main goals that PASION will have to achieve during his time.

2. The PASION project

PASION's working hypothesis is that in mediated environments social communication takes completely new forms and that these forms are due to group interactions in technology-mediated environments. The goal of PASION is to enhance the effectiveness of mediated and media-assisted communication in a group setting – with the ultimate goal of improving the performance of the group. To achieve its goal, the PASION Consortium strongly believes that the real-time capture, interpretation and representation of group metacognitive social psychological, contextual and affective processes can yield key information to inform and enrich traditional interaction, and to create new, emergent levels of social interaction. Technology development in PASION will focus on flexible, scalable, user-friendly and nomadic mixed reality tools, which will provide access to these previously inaccessible levels of social information.

In the four years of the project, PASION will investigate the basic scientific and technological issues which need to be resolved to achieve this goal. Basic research will investigate the socio-psychological foundations of mediated social interaction. Wizard-of-Oz prototypes will be used to elicit user input on basic concepts. Ergonomic studies will investigate critical issues of usability and user acceptability. Using this input, the project will design and develop new techniques to capture information relevant to social communication, and new ways of representing this information to users within the SVE.

As current communication technologies are ineffective in conveying the social, non-verbal and contextual information required for effective communication, PASION will deliver an innovative shared virtual environment where a pioneering mediated social communication will take place. Two trials (one for each specific application collaborative work, and social gaming) will investigate the effectiveness the concepts and technologies incorporated in the environment. During trials PASION will be used by "large community of mobile users" providing strategic support to the activity of the group (adapted to the needs of specific applications in collaborative work and social gaming) by implementing "specific feedback strategies" based on the interpretation of

the state and dynamics of social communication within the group. Finally a special effort will be dedicated to the investigation of the complicated ethical issues raised by this work, and to plans for business development.

3. Project objectives

3.1. Social communication through technology

Traditional communication media such as letters and the telephone created and preserved social bonds and interpersonal relations across borders and oceans. By contrast, today's electronic communication media –TV, computers and the Internet– seem to have reduced the motivation for and the quality of social interaction. Olson and Olson (2000) provided us with a satisfactory review of literature on this topic see. One of the reasons is that electronic media transmit too little: they are ineffective in conveying the subtle social and contextual information which plays such an important part in non-mediated communication. But another reason is that they transmit too much, they monopolize on users attention distracting them not only from the task-oriented purposes of social interaction but even from its socio-emotional implications.

Ever more frequently, social and particularly group interactions, involve mediated communication. Yet we know very little about the factors determining the effectiveness of the interaction. How do participants in mediated communication substitute the implicit, and non verbal signals which play such an important role in traditional, face to face communication? What are the equivalent signals in a mediated environment? The mechanisms involved in traditional communication are well-known. By contrast, very little is known about the forms of mediated communication. For instance, we do not know the role of implicit and non-verbal communication when the communication takes place in a mediated environment. We have a broad range of strategies to improve cooperation and performance in traditional groups (e.g. through training to improve group skills, games to increase motivation or to simulate a concrete activity). All of which raises a fundamental question: how can we change –and use– technology to facilitate technology-mediated group communication and to increase the effectiveness and performance of the group. It is this question which motivates the PASION project.

3.2. Strategic goals

The basic research, technology and applications development planned by PASION focus on improving the efficiency and effectiveness of goal-oriented groups engaged in social (many to many) communication, in mediated environments, with a particular emphasis on large groups in which communications are maintained on a long term basis (e.g. professional communities) creating a social network.

To achieve this goal PASION will conduct basic research on patterns of mediated communication (on multiple time scales) within large, persistent social groups. This research will study the relationships between emotional and implicit communication in mediated communication, different patterns of group interaction and the performance of the group.

The group will work and interact within a Shared Virtual Environment (SVE) supporting the activities of users (e.g. collaborative work, gaming) and the many to many communications required by these activities. Within this environment, PASION will substitute the channels of non-verbal and implicit communication available in non-mediated communication with new forms of communications, appropriate to mediated environments.

PASION will provide means to monitor the behavior of group members and group dynamics on multiple time scales (short term inter-individual interactions, overall patterns of interaction during a meeting or a gaming session, long term trends in group "connectedness"). The system will construct synthetic indexes showing and comparing dynamics and indicators relevant to different time scales. Using this data, PASION will look at different strategies for providing feedback (including emotional cues), which improves the quality of group interaction.

At an early stage PASION will use basic augmented and mixed reality technology to provide partners in long-distance communications with a range of different channels (e.g. simple visual signals in peripheral vision, 3-D audio, eye tracking, social network analysis tools) to monitor the social mediated communication within the group. On the basis of this initial studies the medium-term (4 year) goal of project will be to investigate the basic scientific and technological questions to be resolved before this goal can be achieved. What cues do they use? How do they use information about the social context in which communication is taking place? What is the role of group dynamics? In technological terms: how can we substitute for social information and the non-verbal channels of communication humans use in their social interactions? How can we capture, interpret and process user behavior in a group context? How can we capture

the user's context (is she in a meeting, writing, resting, driving, waiting for a call) and the more general group context? How can we represent this information to distant communications partners? How can we do this in ways which are non-intrusive? In terms of applications, what can we do with new "social communication technologies" that we cannot do with current systems? And how do we know if we are succeeding? To find answers to these questions, PASION proposes an integrated program of research bringing together basic research, technology integration, user-centered applications design, trials and evaluation.

3.3. Scientific goals

Traditional computer-mediated social interaction lacks the subtle social cues that we use to guide and structure our real world encounters. In a digital world we are socially blind and our attempts to communicate become awkward and labor-intensive. PASION's key scientific goal is to discover how mediated communication affects long and shorter term dynamics of group behavior in a social network and to investigate dependencies between these effects and the broader context of the communication (e.g. conflict and conflict resolution, competitive or collaborative communications). To this end, the project will investigate the nature, semantics and forms of mediated communication during competitive and collaborative group interactions (e.g. during collaborative work, in a game), explore means of making social and other contextual data explicit, and investigate how this can affect the overall performance of the group.

3.4. Technology

Creating a new generation of communications environment and tools will require new developments in the automated detection, analysis and representation of group and individual behavior. To understand the characteristics and forms of socially mediated communication PASION will develop a Shared Virtual Environment in which it is possible to monitor mediated social interactions among members of a group. A specific project objective is to identify strategies (in the form of services, tools and cues) capable of empowering the individual members of the group and the group as a whole.

This work will involve new techniques of data fusion, transforming low level behavioral data into higher level representations. And it will require architectural and integration work to allow groups of (ultimately mobile) users to share and access this data. The

Shared Virtual Environment will support the activities of users (e.g. collaborative work, gaming) and the many to many communications required by these activities.

Initial research will use classical techniques of analysis to capture and analyze the behavior of the group and its components and to provide users with appropriate social and emotional cues. Experimental work will analyze long and shorter-term patterns of group interaction applying techniques from social network analysis. At an early phase of the project off-the-shelf technologies will be used to capture individual behavior and to provide contextual information and emotional cues to users: e.g. non-obtrusive sensor technology for the detection of emotional arousal and attention; high resolution, high accuracy eye tracking for avatar control and attention feedback in e-learning applications, low-cost sensor technologies for increase emotional involvement and social presence in net-communications; PC-based Automatic recognition of attention profiles and emotional user states as input for adaptive systems (agent systems and ambient intelligence); non-intrusive methods for displaying information to users; The use of mobile technologies in mobile contexts will be also probed. The use of group-centered emotion regulation and group processes as therapy for relieving work stress and increasing well-being will also be studied. Based on this research a design space will be formalized based on which concepts are generated.

The long term (10 year) goals of this work include tools to understand the group communication and behavior in mediated environments and to offer “specific feedback strategies”. Goals to be achieved within the life-time of the project include: identification and (where needed), development of new ways of processing sensor and other data to reliably detect and measure group behavior (patterns of interaction among users on different time scales, patterns of interaction between users and virtual objects in the shared environment, identification and development of elegant, effective and meaningful means of representing sensed data for transmission and sharing with others; integrating these developments in a Shared Virtual Environment.

4. PASION research strategy

PASION research activity is structured into 3 main areas: mediated social communication basic research, technical development of the PASION system, PASION application design.

4.1. Social presence as mediated social interaction: PASION basic research

The first research activity area is dedicated to basic research in the field of mediated social interaction. In particular the PASION team will work to identify the salience of socio-emotional communication cues, contextual and situational information in mediated and media-assisted communication and to test the effects of making such information explicitly available to communicating parties, both at the individual and group level. The main objective is to develop a coherent theoretical framework regarding the fundamental role of implicit communication and contextual information in social interaction and to create laboratory tools for basic research into the effects of implicit communication and contextual cues. This will demand basic research into patterns of mediated and non-mediated communication within social groups, focusing on socio-emotional communication cues, place and contextual information on various group scales and on multiple time scales and how to translate these into meaningful synthesized and integrated indicators to enhance and enrich situated group awareness and social interaction.

On the basis of first understanding of the contextual cues effects (sensing, interpreting) the project will identify specific requirements for creating situated social awareness in mediated environments: to determine the spatio-temporal characteristics of successful social interaction environments at micro, meso, and macro level, i.e., in private, semi-private, and public spaces; and to explore basic technological requirements for the detection, transmission and display of social and situational cues and traces of group behavior integrated over time and place, in the form of synthesized and integrated indicators that influence social interaction in virtual encounters. The research activity will be performed trough the following tasks:

- First PASION will survey current indexes of social activity during communication and to investigate how these might improve the effectiveness and efficiency of future communication tools; this study will provide relevant and systematic knowledge of the role of implicit communication cues for social interaction and collaboration, building a comprehensive grammar of transient non-verbal and implicit social communication and contextual cues. The indexes will consider (at least) three related themes: Communication style and strategies (the way in which communicants' contributions coordinate or collide, in terms of turn allocation, overlaps, breakdowns, gaps). Social Positioning (the way in which users' interdependent positions, are balanced on dimensions such as reciprocation, politeness and mode of participation –

centrality-peripherality, initiators versus follower), and Social Microsuasion (indexes directly used by participants as a form of social evaluation and as a tool to affect group communication dynamics).

- Second on the basis of the empirical research conducted PASION will provide basic knowledge on the effects of embodiment and non-verbal communication in HCI (Human Computer Interaction) and CMC (Computer Mediated Communication), small and large scale settings and will identify the role of social activity, transient social communication and contextual cues in shaping mediated social interaction, and determining relevant emotional cues to facilitate interpersonal communication in mixed reality interactions;
- Third PASION will develop protocols for extracting socially meaningful spatio-temporal patterns from clusters of data from individual sensors, identifying emotional cues relevant to the facilitation of group awareness in virtual encounters; alongside indexes which can be used to monitor and enrich social communication will be identified, through intuitive and easy to understand appropriately visualized temporal aggregates of transient socio-spatial behavior patterns and contextual cues, thus improving emotional and group awareness, will be identified.
- The overall findings will lead to formulate requirements for intelligent mixed reality systems (portable awareness tools) for social facilitation, emotional communication, interpersonal conflict resolution, and persuasion and for flexible platforms and authoring tools for the creation of socially intelligent embodied conversational agents. More in general the study will help to develop a rationale for a new generation of shared environments enriched with socially meaningful contextual information, based on collaboration and exchange between clusters of location-based and devices.

4.2. Architecture design for Social presence: PASION technical framework

The PASION technical team will deploy an extensible platform that will be representative of the PASION project. This platform will make it possible to verify the research outcomes of the basis research (descried above in 3.2), implement the PASION applications (social gaming and collaborative work), and test the PASION vision with real life users. The concrete outcome developed by the PASION technical team will be a prototype Shared Virtual Environment (SVE) suitable for deployment on mobile devices. The prototype will include physical and logical sensors integrating data

analysis software components for the extraction of social indicators, and supporting the two mobile applications planned (social gaming and collaborative work).

The PASION technical framework foresee an advanced, mediated environment supporting experimental investigation of the dynamics and behavior of large groups based on the design of ad hoc technologies which uses social network analysis in a closed-loop system to improve the efficiency and effectiveness of goal oriented groups.

The work to be performed includes the definition of an architecture supporting a many-to-many communication environment. This architecture will be designed to provide users with a broad range of information concerning the dynamics of the group and the behavior and state of individual users, thereby enhancing their social interactions as well as their interactions with the physical and virtual world. Applications built over the architecture will allow users to view this information as well as accessing, and modifying interactive and multimedia content. The platform will be designed on the basis of a data management layer (see below) supporting distributed access, by users and applications, to the information generated from sensor data and social analysis tools. From a higher point of view the PASION system platform will be built onto 3 main layers:

1. ***Sensing layer***: the role of this layer is to receive and process raw data from physical and logical sensors, transforming it into manageable information. The sensing layer will integrate the sensors and prototypes produced at the early stages of the project (from the basic research team), creating a unified logical layer. Each source of information (sensor) will be viewed as a publisher entity, with the ability to track some physical and logic events and to publish the information in a format that is manageable by the data management and application layers.
2. ***Data management layer:*** this layer will have the double task of managing information requested and generated by other components of the PASION platform, and merging the behavioral and state information provided by other modules in the architecture, in a model (or in models) of group and individual behavior. The existence of a data management layer decouples data generation from the way the data is used.
3. ***The application layer***: The application layer is the environment where the two applications will run. The application layer will provide a common interface towards the end-user allowing the user to initiate an application and augmenting the content of the application with social and behavioral information generated by other modules

Based on the platform, the main goals of this activity are to:

- Constitute a new technological paradigm for many to many communication based on social network analysis
- Deploy and test applications with large groups users in an experimental set-up
- Evaluate the improvement the efficiency and effectiveness of goal oriented groups by the usage of the platform

On top of this the platform will have to be an overall system able to track and index human-interface events generated during mediated communication and to publish them in a manageable format. Indexes –suggested by the PASION researchers studying specific aspects of social communication in mediated environments– will be formalized and translated into treatable variables fitted to the architecture of PASION platform.

The work will start with the design, development and testing of a prototype system able to recognize and track basic data (like distances, time, frequency of events) and to transform them into synthetic indexes (e.g. intensity of group activity). Further steps will focus on improving the quality of data collected and of the data be provided by the users during their interactions with applications. Special tools will allow users to rate an event, express an opinion and so on. Indexes or the result of their manipulation, will be visualized as graphics, indicators, warning signals etc. thereby providing users with "social feedback". Most components of the systems will be customizable by administrators (e.g. requests, rating system scale). Some indexes will be contextualized to the characteristics of the specific environments and characteristic objects in the environment. A relevant aspect of this activity will be the effort on data analysis and fusion techniques to be developed for the extraction of meaningful measurements from data streams associated with social interaction indicators and nonverbal behavior (gestures, facial displays, gaze, body movements and postures). Required representations will be provided for the processed data on several layers from sensorial layer, movement and expressions patterns to semantic content and finally the goals of the interacting participants High-level multi-modal interpretation and classification of these pattern will be subsequently performed. Behavioral and physiological measurements will be provided in an integrated time-series data protocol that will serve as a basis for psychological analysis to identify the relevant signals provided by the outcomes of studies performed in the field of social communication and social presence (see 3.1).

4.3. PASION customized application design

The system developed by PASION will be tested in two applications: social gaming and collaborative work. User communities will be able to use the normal functions provided in this kind of application (e.g. collaborative tools, multiplayer games) which will be integrated in the SVE. The services offered by the SVE will allow users to conduct their normal activities with strategic support from PASION. PASION will be able to monitor and provide support for group activities (work, gaming) through "specific feedback strategies" based on the interpretation of the state of mediated social communication within the group.

Collaborative work

Modern knowledge work involves formal and non-formal communities of practice. One example of a formal team would be an R&D project team including members from different companies, with different cultural backgrounds; non-formal teams can form spontaneously as when an informal social network of experts shares knowledge in their area of expertise. Teams are characterized by their knowledge creating and sharing activities rather than organizational boundaries.

Effective social communication within the team is a pre-requisite for effective brain-storming, problem-solving etc.. Studies have shown that non-verbal and implicit signals (e.g. smiles and frowns, signs of approval and disapproval) play an important role in facilitating group performance. This is especially important when: i) participants' tasks are time critical and driven by deadlines, ii) the result or success of the work relies on the creativity of autonomous, but interrelated people, iii) there is a culture of co-operation and sharing of knowledge amongst people and iv) people are mobile and distributed (Fagrell, Forsberg, & Sanneblad, 2000). The lack of effective technology for conveying these signals is one of the key factors limiting the use of remote communications in business.

Davis (2002) describes possible beneficial effects of distributed computing. These include: i) enhanced capabilities for communication, coordination, collaboration and knowledge exchange, ii) removal of time and space constraints for doing knowledge work, iii) access to critical decision makers at any time and iv) increased ability to receive and process rich streams of signals about the organization and its environment.

PASION's primary goal in this area is to understand the factors that influence team performance during typical knowledge tasks (e.g. learning, knowledge transfer, brain-storming, product design) within a mediated environment. The second goal is to create

SVE that will facilitate these tasks, creating improved team awareness and contributing to the performance of organizations using the tools. In the final stage of the work, the team will use qualitative and quantitative techniques (group behavior in mediated environment tracking, ethnographic techniques, laboratory studies, etc.) to measure the effectiveness of the technology produced. Tools usually used by workers will be integrated in the PASION system and technologies and to0ls within the SVE will provide an additional channel for social group awareness trough the support of "specific feedback strategies". A key goal is to support collaborative work with **mobile devices.** The development of the final mobile interface will allow the effective communication of the social signals as required by the tool design.

Social Gaming

One of the most important activities in which humans communicate socially is play. Not surprisingly software companies and games manufacturers have a strong interest in the business potential of multiplayer online gaming. After many years in which the only communication channel in games was through text and avatars, several online services now incorporate voice communication as a standard component (Available on http://www.xbox.com/en-us/live/default.htm). Communication nonetheless remains relatively poor and there is little evidence that current commercial games produce the complex social dynamics that characterize physical play.

The long term goal of PASION is to pave the way towards mobile games where the emotional state of a user can be communicated and manipulated as part of the game or experience. Social computer games will embed some of the variety and rich social interaction we see in the playground, but will attempt to capitalize on the affordances of mixed reality as a medium for bringing players together. The design and the evaluation of these games will be based on a sound theory of social presence that will cover the social effects and antecedents of social presence and co-presence. A second key goal is to support multi-player social gaming on **mobile devices** – an important market for the future which major manufacturers are only just beginning to explore.

PASION's primary goal in this area is to understand the factors that influence gaming performance during typical tasks (e.g. competition, simulation, etc.) mediated environment. The second goal is to create SVE that will facilitate these tasks, creating improved multiplayer-awareness and contributing to the performance of to be realized in the game. In the final stage of the work the PASION team will use both qualitative and quantitative techniques (group behavior in mediated environment tracking,

ethnographic techniques, laboratory studies, etc.) to measure the effectiveness of the technology produced. Tools usually used by gamers will be integrated in the PASION system and technologies and tools within the SVE will provide an additional channel for enhancing social group awareness via “specific feedback strategies”. A key goal is to allow gaming on **mobile devices.** The development of the final mobile interface will allow the effective communication of the social signals as required by the tool design.

In parallel with this work, the project will develop common platform requirements that will emerge from the experiences of the project. Elements of common utility will be factored out of the game, and interface components and delivered as self-contained elements to the shared virtual environment. An instruction manual will be created with the purpose of supporting the re-use of the interface elements and social signaling measures in the context of the broader project. The development and testing of the game will proceed in parallel with additional technology work designed to facilitate the development of mixed reality games incorporating ever stronger elements of social communication. A key goal is to facilitate the design and implementation of “plastic” user interfaces, suitable for use in different sized rooms with different numbers of players.

5. PASION Living trials

Achieving PASION’s long-term goals will require many years of development. It is essential that this development should take account of research into the way social interactions can be affected by the introduction of technology. A key goal of the project is to practically assess the social ergonomic implications of the technologies it is proposing. PASION will therefore to develop scenarios, concepts, prototypes and applications from a very early stage in the project, to test these with users, and to use the results as a source of new research questions and new directions in technology work. The aim of the PASION trials will be to:

- Provide a real-life test of PASION services and the SVE and test the scientific and technical choices underlying the project
- Test the specific scientific hypotheses proposed by WPG2 (based on early measures using environments comparable to those developed in PASION but with much more primitive technologies) using an advanced environment
- Tune the “free parameters” in PASION’s complex, closed loop architecture

Experimental studies will investigate the cognitive processes involved in the use of different PASION tools, including the recognition of their affordances in the processing of perceptual (specially visual) stimuli (Ware, 2004), the trade-off between performance and skill-, rule-, knowledge-based errors (Reason, 1990). In testing the PASION systems the project will study the way in which relationships with other people (present or represented) are represented in different scenarios (Rosson, Carroll, 2001) persuasive cues (Fogg, 2003) interaction patterns and norms; turn allocation; sequence organization and repairs (Have, 1999); establishment of common ground (Clark, Brennan, 1991). The planned investigations will use a use a broad range of methods likely to include: ethno-methodologically informed analysis of use contexts; cognitive task analysis; quasi-experimentation, compensatory strategies and attention distribution strategies during multiple tasks. In the second half of the project it is planned to organize trials which involve large numbers of mobile users.

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