User Centric Systems: Ethical Consideration

Nikola Serbedzija

Fraunhofer FIRST Berlin
nikola@first.fraunhofer.de

Abstract. User-centric systems call for novel methods and tools for a tight and implicit man machine interaction. Often highly personalized system are sensitive and reactive to user psychological, social and physical situation. However providing such a support may cross the barriers of our privacy or may have impacts on us that we do not necessarily agree upon.

Keywords: pervasive adaptation, ambient assistance, ethical issues, privacy protection.

1 Introduction

Nowadays, computers have become an integral part of our everyday surroundings making it necessary to re-thing and re-design ways in which we cooperate with computers. To make a control system a genuine companion in everyday life, it should be enriched with some adaptation capabilities to adjust its functioning to the users' needs. Otherwise, a modern homo *technicus*, as intrinsically adaptive species may, due to his permanent and enthusiastic exposure to ridged artificial systems, experience unpleasant retrogressive changes.

A perfect man-machine ccollaboration should minimise explicit interaction and maximise the functionality of the system. The goal is to avoid giving commands to a control system, but rather enabling the system to understand what is needed in given circumstances. In a similar way that text editing has been revolutionized by the „what you see is what you get" principle, the motto "what you need is what you get"[1] is radically changing the landscape of man-machine interface.

As an example of user-centric approach to man machine interaction, the reflect system is described, followed by some examples of its use in practice. Afterwards, impacts of new technology, such as privacy and trust issues, are discussed and ideas for further work are given.

2 Reflective Approach

The approach described here is called reflective as it observes people in their activities and reflects their need by adjusting the control system accordingly. Observation is done through numerous sensor devices that collect information. Based on the collected information, an analysis is performed that results in emotional, cognitive and physical diagnosis. Taking into account the detected user state and the

P. Sénac, M. Ott, and A. Seneviratne (Eds.): MobiQuitous 2010, LNICST 73, pp. 431–438, 2012.

system goals, the functioning is adapted to the users' needs, making the control system naturally embedded into wider surroundings.

As an illustration one application scenario is given, followed by some requirement analyses, psychological consideration and implementation issues.

2.1 User-Centric Applications

An example of user-centric systems is the driving assistance. Especially in the situation of a longer lonely drive or in a tense traffic situation, the driving assistance may substitute a missing co-driver and improve both safety and pleasure in driving. The reflective vehicle [2] implements such scenario and is equipped with numerous sensors for detecting facial expressions, postures and psychophysiological measures (electrocardiogram, heart rate and heart rate variability, respiration, etc). Further sensors is a vehicular data bus system (e.g. CAN bus) that offers numerous real-time date about the driving and engine condition (pedal pressure, wheel corrections, speed, etc). The sensors are used to monitor and diagnose the driver's state in a specific driving situation. The vehicle is also set with actuator devices like "reflective console" that give warnings, reflective media player and reflective seat (that re-shapes to match the driver's comfort) [2]. The reflective vehicle actually plays a role of a friendly co-driver that observes the driver, assists in driving and makes the trip safer and more comfortable.

The reflective control system that implements the above mentioned scenario, has to be capable of adaptation, featuring dynamic adjustment of its functioning according to the real-time situation. Different types of adaptation are considered:

- Immediate adaptation – a capability of reacting in a moment when a sudden change occurs (e.g. mastering difficult driving situation)
- Short term adaptation – a capability to adjust to a more complex situation which requires some time to be comprehended (e.g. improving overall emotional state and comfort of the driver)
- Long term adaptation – a capability to learn over a longer period of time and adjust to a personal needs of individual users (make the above adaptation personalized and relative to the individual driver)
- Pervasive adaptation – a capability to exchange knowledge with other systems and to act adaptively in different settings and in any situation.

Reflective systems aim at all above mentioned varieties of adaptation which constitute the major system requirements.

2.2 Psychological Background

One of the most striking features of nature that ensures evolution and progress is adaptation: a capability to self adjusts according to changing conditions. In effort to mimic the adaptation in artificial system and deploy it naturally in man-machine interface, this approach takes the biocybernetic loop as a starting point. Originally, the loop [3] describes how psychophysiological data regarding the status of the user are captured, analyzed and converted to a computer control input in real-time. The function of the loop is to monitor changes in user state in order to initiate an appropriate adaptive response.

Reflective approach extends the original concept of biocybernetic loop [4] to a wider set of input information allowing for a composite analyses and decision making. It takes results of affective computing and combines it with higher level understanding of social and goal–oriented situations. The approach is multi modal as it takes into account different kinds of information, processes them in multiple loops and at different time scales. There are three major phases of a single loop: sense, analyses and activate. These phases are repeated endlessly, where each consecutive cycle takes into account the effects of the previous one performing constant self-tuning and optimization.

Based on a better understanding of both personal involvement and social and behavioural situation of the user, a reflective system may offer adaptive control of different types and different time scales: immediate, short-term adaptation, long-term adaptation. It also supports pervasiveness, as an orthogonal dimension to previous type of adaptation, providing interfaces to other similar systems, anywhere and at any time.

2.2.1 Immediate Adaptation

Immediate adaptation is a prompt system, reaction to any phenomenon taht system becomes aware of. Awareness implies knowledge gained through one's own perceptions or by means of information. At a fundamental level, awareness describes the ‘field of view’ of the system, i.e. the range of events that the adaptive system is capable of responding to.

In a driving situation, any driver may experience difficulties in navigating through narrow lanes in a stressful traffic situation (e.g. reduced visibility or ice). The system becomes aware of this change in driver state via increased heart rate or reduced heart rate variability as well as frequent corrections of the steering wheel detected via vehicular CAN bus. In this case, driving assistance disables incoming phone calls and reduces the volume of the car entertainment system.

2.2.2 Short Term Adaptation

Adjustment is a typical example for the adaptation seen as an act of change, “so as to become suitable to a new or special situation”. A system adjustment at a moderate time scale is implemented through the biocybernetic loop that monitors behaviour with respect to a certain goal or in achieving a planned state. In the application domain it may be best illustrated by achieving comfort (positive physical state) in driving process.

The reflective vehicle may be capable of influencing disposition of the driver, to prevent negative moods such as boredom or anger and to promote positive moods of high activation (alertness) and positive affect (happiness). The driver’s mood is accessed via cameras for facial recognition combined with psychophysiology. However, changes in mood take place over several minutes and the system requires a moderate time scale in order to detect a negative mood such as anger. Once diagnosed the driver’s emotional state is influenced by appropriate music and lighting.

2.2.3 Long Term Adaptation

Long term adaptation or evolution can be defined as a gradual process in which something changes into a different and improved form - a modification that happens over a longer period of time. An aspect of evolution is a dynamic form of personalization where both system and user respond to repeated exposure to one another.

In the vehicular emotional adaptation, the system monitors the user state in order to formulate an appropriate adaptation which also includes keeping record (in database) on driver's personal reaction to the assistance offered by the system. This personalized database may be subsequently used to tailor system behaviour to the individual over hours, days, weeks, and months. Therefore, the system must continue to evolve and to experiment with different adaptive responses in order to "refresh" the interface with the user at a longer term.

2.2.4 Pervasiveness

Pervasiveness denotes the quality of filling or spreading throughout. Pervasiveness of a reflective system is an orthogonal concept to adaptation that introduces collaboration and data exchange across different reflective systems. In addition, pervasive technology brings the potential to enrich information about the current state of user by pooling information across systems.

In vehicle, reflective assistance have capability to connect to other control system from traffic or city infrastructure and with data exchange (taking into account knowledge about user, her/his preferences and goals) provide better services.

2.3 Reflective Approach

To accomplish the requirements of pervasive adaptive systems, a service- and component-oriented middleware architecture, has been designed and developed [5,6,7]. It insures a dynamic and re-active behaviour featuring different biocybernetic loops. The reflective software is grouped into three layers: (1) Tangible layer - a low-level layer that controls sensor and actuator devices; (2) Reflective layer - a central layer - that combines input from lower layer to evaluate user states and trigger system (re-)action, according to the application goals. (3) Application layer - a high level layer that defines application scenario and system goals. By combining low and high level components from other layers, application layer runs and controls the system.

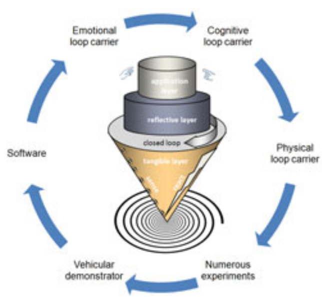

Fig. 1.

Fig. 1 Reflective framework illustrating the reflect layered architecture and the process of the reflect application development and deployment In the middle of the picture a layered architecture is metaphorically pictured as a spinning top, as it operates in endless loop, performing biocybernetic processing. In the outer circle, a development and deployment process is indicated featuring emotional cognitive and physical experience (loop carriers). Pervasiveness is exercised through numerous experiments and case studies and vehicular demonstrator brings all together into a pervasive and adaptive application [5].

2.4 Reflective Vehicle

The reflective vehicle system is a combination of all three major experiences modules configured into a single pervasive reflective application. The resulting system helps the driver throughout the ride, observing emotional, cognitive and physical condition and actively trying to assist in the process of driving.

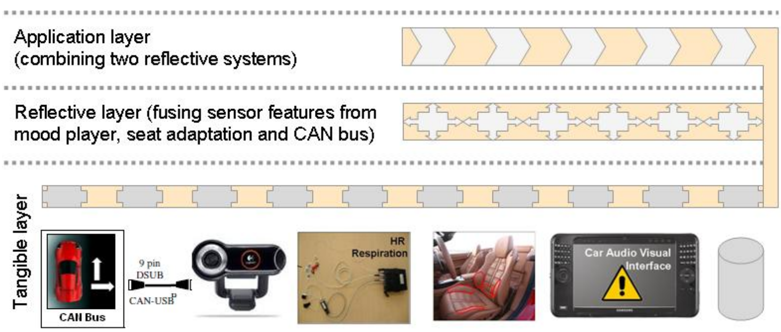

Fig. 2. Reflective vehicle configuration

Figure shows the reflect middleware configured for vehicular assistance. The sensors used are: CAN bus, cameras, physiological measurement devices, equipped with reflective interface. The actuators are: adaptive seat and the 3 board computers (playing the role of the system monitor, mobile phone and media player).

Fig. 3. Reflective cockpit

Figure shows the cockpit of the reflective vehicle with three on board computers, adaptive seat and cameras installed in front of driver. System has been tested in practice and effectively justifies the pragmatic orientation of reflective approach [5].

3 Impact - The Use and Consequences

The ultimate goal of reflective approach is to make future control systems genuinely friendly and personalized to suit the needs of individual users. To achieve this goal it is not enough to create interfaces that suit an average users, but to make it really serves the personal needs, taking into account current necessities as well psycho-physiological state of the persons being involved in real-time. At one hand, emerging systems that are reactive to human senses can be interpreted as our technical "sixth sense", at another we should be aware that our personal identity is being exposed to the interconnected world whose meta-goals may be different from our expectations. This raises ethical concerns: Can we trust the systems? Do they respect our privacy? What is a long term impact of such systems?

Knowing how interconnected the digital world is[8], recording what we buy and eat, where we travel, sleep, rent-a car (e.g. credit card institution), what we read (e.g. Amazon), what we write or visit at the Web (our internet provider), how much fun we had (e.g. Flickr), how we socialise (e.g. Facebook), how our biometric signature look like (e.g. custom control), our medical record (health insurance smart cards) we can fully relax and let "Infosphere" [9] assist in most of our every day activities. The digital divide is sharpening, "digitalize or perish" seems to be the motto – those who are left behind the digital curtain belong to third (digital) community. With the technology described here as well as with neuro-science that is making a huge progress in the domain of brain-computer interface we are about to submit the last fence of our privacy to the "digital consideration". Namely our feelings, mental constitution, even our thoughts.

Certainly, the use of modern technology facilitates the life, provides efficiency, comfort and smooth communication in a way it could not be even perceived a few decades ago. Especially the applications in medicine and ambient assisted living domain represent clear justification of the recent achievements. Nevertheless, a potential for misuses is wide and what is even more disturbing, neither possibilities nor risks are properly understood.

In that context the observation given here can be described as "nano-Ethics" focusing only at a small segment of the problem – where technology may help. For example, making reflective systems closed by strict separation of psycho-physiological and administrative data, and making it technically impossible to exchange information with other systems – would be a step in right direction in protecting the privacy.

The problem of the impact of the new technology to our life and society as a whole is neither new nor unsolvable [10]. Due to rapid developments it is sharpening though, and needs to be addressed from different viewpoints involving wide and cross-disciplinary discussion. The roles are traditionally divided among:

- artists who picture the universe in a free and imaginative way [11] with a free mind calling for re-thinking, re-consideration, re-involvement, esthetic, *l'art-pour-l'artism*, …
- scientists and technology providers who are not only responsible for the development of novel ideas but also for hints on how to technically deal with possible ethical concerns [12].
- philosophers and sociologists as leaders in considering the impacts of new technology to the society as a whole [9,11].
- low makers and politicians to insure efficient legal background and deployment [13].
- practitioners and industry to respect regulation and ethical norms while making commercial and other use of modern technology.

In one of his articles, Floridi [9] introduces a neologism *Infosphere* as a collection of informational entities that inevitably constitutes the environment that supports our life. To further understand the impact of the *Infosphere* to us (as *Infogs* – informational organisms), the author introduces "*re-ontologization*", referring to fundamental transformation of our environment as a consequence of digitalization and *Infosphere*. Such a complex approach allows for thorough reasoning about the meaning, impact and ethics of *Infosphere* as a non-avoidable part of our ecological system.

4 Conclusion

The paper presents a novel approach in building smart systems illustrating both its technical background and its applicability. Reflective approach, being highly user-centric, makes a person's behaviour a part of processing loop and body area network an integral part of a wider system. However, a fast and uncontrolled deployment of smart technology may bring dangers and have negative impact on us. The paper further discussed how to prevent that the "digital victory" does not turn into a *Pyrrhic* one, as the use of massively interconnected digital devices may endanger our privacy exposing all aspects of our behaviour from the everyday activities, work competences, habits, feelings, intentions up to our inner thinking. Negative consequences may be prevented, if the design of new technology takes into account privacy concernes and integrated protection mechanism into the systems in all phases, namely design, development and deployment.

It seems that the one of the main controversies a modern society is confronted with is not the rapid technology development which sometimes goes even beyond science-fiction, but rather the slow pace at which humanities answer, or are allowed to answer to the new moral challenges. Their main task remains to be to warn about possible nightmare scenarios. Orwell's greatness (Orwell, 1949) cannot be measured by the fact that he envisaged many abuses already present nowadays, but rather by his warnings which helped that his worst predictions haven't (yet) became true. Therefore, an interdisciplinary approach is a *conditio sine qua* non in all future research programmes.

The spectrum of further challenges that still needs to be researched crosses various disciplines. Psychology needs to offer more expertise on diagnosing different emotional and cognitive states. Better methods and tools are needed to analyze and filter-out raw sensor data in order to get clear features (that may lead to more precise determination of different psychological states). Social sciences and philosophy should investigate the impact that such user-centric and personalized approach may have on us, as it is clear that we also do change and evolve through constant exposure to technical systems that surround us. Finally, technology providers need to take into account not only technical benefits that envisaged systems should bring, but to try to find technical solutions that support privacy, trust and insure positive impact to us as biological and social beings.

Acknowledgement. Most of the work presented here has been has been done under the REFLECT project (project number FP7-215893) funded by the European Commission within the 7th Framework Programme, pervasive adaptation initiative.

References

1. Serbedzija, N., Bertolloti, G.-M.: Adaptive and Personalized Body Networking. In: Proc. Bodynets 2010, Corfu, Greece (September 2010)
2. Serbedzija, N., et al.: Vehicle as a Co-Driver. In: Proceedings First Annual International Symposium on Vehicular Computing Systems, ISVCS 2008, Dublin, Ireland, July 22-24 (2008)
3. Pope, A.T., Bogart, E.H., Bartolome, D.S.: Biocybernetic system evaluates indices of operator engagement in automated task. Biological Psychology 40, 187–195 (1995)
4. Fairclough, S.H.: Fundamentals of physiological computing. Interacting with Computers 21, 133–145 (2009)
5. REFLECT, REFLECT project - Responsive Flexible Collaborating Ambient (2010), http://reflect.first.fraunhofer.de
6. Schroeder, A., Zwaag, M., Hammer, M.: A Middleware Architecture for Human-Centred Pervasive Adaptive Applications. In: 1st PerAda Workshop at SASO 2008, Venice, Italy, October 21 (2008)
7. Beyer, G., Hammer, M., Kroiss, C., Schroeder, A.: Component-Based Approach for Realizing Pervasive Adaptive Systems. In: Workshop on User-Centric Pervasive Adaptation, UCPA 2009, Berlin, Germany, April 27 (2009)
8. Norman, D.A.: The Design of Future Things. Basic Books, New York (2007)
9. Floridi, L.: A look into the future impact of ICT on our lives. Information Society 23(1), 59–64 (2007)
10. Orwell, G.: Nineteen Eighty-Four._A novel. Secker & Warburg, London (1949)
11. Hettinger, E.: Justifying intellectual property. Philosophy and Public Affairs 18, 31–52 (1989)
12. Rulon, M.: New Technology Raises Privacy Concerns, USA Today, http://www.usatoday.com/tech/news/surveillance/2006-08-31-rfid-privacy_x.htm (accessed April 30, 2009)
13. EC. The European Group on Ethics in Science and New Technologies to the European Commission. Ethically Speaking (9) (2009)