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Second order ambient intelligence

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Abstract. This text attempts to describe an imagined future of ambient intelligence. It assumes that one day most of the current issues within ambient intelligence will be solved and that a second order ambient intelligence will be formulated, one with new research agendas. It describes several topics and ideas that might be part of this agenda and surmises on the prerequisites for this change.

Keywords: Critique of ambient intelligence, temporal design, adaptive systems, long-term behavior, animal machine interaction, critical futurism, second order ambient intelligence

1. Introduction

Ambient intelligence (AmI) is still a comparatively new field of research. As in many new fields of inquiry, its current state is far from what AmI-researchers and professionals believe it capable of. Unfortunately, many AmI systems you can actually experience today leave you wondering what all the excitement is about. I recently visited a smart house that has wall to wall voice control to activate curtains and open windows. Speech recognition is notorious for its unreliability in noisy environments and unconstrained vocabularies. The proud home inhabitant, hired by a company to demonstratively live in this smart house, used a microphone headset in an attempt to keep the signal to noise ratio between his voice and the inevitable background noise at a level the voice recognition system could cope with. The system designers were well aware of the potential of miscommunication between speakers and voice activated control systems, and added an additional level of robustness in the usage scenario. Each voice command was preceded by a signature prompt that cued the listening system to the incoming command. The signature prompt was cast into a form of addressing people are familiar with: a name. So the house had a name, a name that sounded spiffy and could be picked up easily by the AmI system, readying it for the actual command intended for execution. The idea is compelling; a perfect solution, one that combines a state of the art technology with useful best-practices to increase robustness; one that includes integration into established social norms. The reality was different however. The presenter trained in using the system, found himself repeating commands various times during the demonstration. Each one was preceded by the house name as if he were calling a disobedient dog. Our loud and boisterous comments in the background only made the situation worse. The window shades opened and closed out of sync not unlike the gadgets in the Villa Arpel of Jacques Tati's *Mon Oncle* [17].

2. Ambient intelligence meets resistence

There is no lack of critique of ambient technologies. This should be no surprise to the AmI community, especially given the manifest discomfort more and more people express vis-a-vis ubiquitous surveillance technologies. Indeed, the AmI community's responses have been insufficient to date. The conceptual slack has been taken up in the interim by the social sciences. In *Everyware* [12], Greenfield for example argues for selectivity in deploying ambient systems and reminds us that fewer well designed systems are preferable to a plethora of poorly designed and indiscriminately deployed technology. However, not all the dissenting voices have something really interesting to say. The discussion that follows here is geared not to imagining less AmI but a different kind of AmI.

3. One short story on the future of ambient intelligence

For the sake of argument lets assume that, some time in the near future, AmI in the home, the office, factory and mall will have matured. Lets assume AmI will have found a way to open and close windows on command, reliably and through interfaces people naturally use. Lets assume that AmI will be able to respond to wind, rain and sun and people's most obvious daily needs such as lighting, indoor climate control and the like. Lets assume that such systems would be reliable and cheap enough to be deployed in mass markets. Lets assume that they would disappear into the background when not in use and remain unnoticed except when active. Lets assume that in this near future AmI will anticipate obvious needs such as the restocking of supplies or the coordination of house maintenance services. When all that is done and ready, where will AmI move to next? What follows is a short fictional account of one of many possible paths towards these next steps.

3.1. Ambient intelligence meets our expectations

AmI will improve its existing portfolio of features. Responsiveness will be refined. Better sensors will deliver higher resolution data, and better evaluation algorithms will parse the data more reliably and reduce annoying false positives and false negatives that plague many sensing systems today. And responsiveness will make way for adaptiveness. Sensing systems will be able to operate reliably over a wider range of operating conditions. Vision systems will work reliably in both broad daylight and at night. Heating systems will be replaced by climate comfort systems that adapt temperature, humidity, air pressure, air motion and fragrance for optimal comfort and pleasure in all climates and situations. Ikea malls will have their roofs covered with cheap solar panels and fall off the electric grid inviting more guilt-free shopping of energy conscious consumers. Biometric entry systems will be able to handle sweaty hands and children's tiny fingers. Many fewer false alarms will be heard in airports and at boarder crossings around the world. Things will finally be working properly. All this is not difficult to imagine.

3.2. Personalized ambient intelligence

AmI will engage artificial intelligence even more thoroughly than it does now, as Ramos [19] foresees. And within AI, machine learning will likely receive most of the attention. Detection of subtle patterns culled from large amounts of data will give AmI new robustness. With technical robustness in place, AmI can move towards addressing social robustness for better interaction. The current cookie cutter interaction that AmI systems display will be replaced with finer grained and culturally sensitized versions. We will no longer speak slowly and carefully to voice recognition devices. And the synthetic voices that acknowledge our wishes will not longer do so in consistently friendly and annoyingly enthusiastic fashion. The keyboard and mouse will all but have disappeared from interaction with computers. And with the demise of the keyboard and the coming of age of mature voiced interaction, behavior will become the mode of information transmission. Gaits and gestures will be read and verified for authenticity as signatures are. Whether it is a handshake or a credit card swipe, your gestures will be meaningful as never before. Our whole body will become an input device. Some personalized AmI will overshoot the boundaries of decorum. Talied body metrics and the caloric value of your workout efforts might be sent to social networking sites if you do not explicitly opt out of the service. Despite endless trivia, new forms of presence will arise from the aggregate of endless messaging, allowing people to co-presence with each other [20] and define new forms of decorum. Televisions will lower the volume when families fight, and properly guess when the fight is over. Privacy will become a design feature delivered by privacy designers not unlike van Kranenburg [16] describes. The unbridled surveillance creep that current greedy ubiquitous technologies such as RFID demand, will eventually be seen as too primitive. The social costs of discontent will bend market forces over time to more selective solutions. Surveillance free spaces will become common.

At home information devices will customize content and delivery modalities, not just interfaces. Domestic robots integrated into AmI enabled houses will know when to get out of our way. Facial emotion recognition systems will be able to distinguish between subtle expressions. The clownesque facial distortions of anger, fear and pleasure that machine vision can detect today will be material for comedy shows tomorrow. Computer designers will have learned lessons from cultural diversity advocates and gobble up every cultural event independent of its origin into a down-loadable feature for your AmI house. Buddhist mediation sessions. Shiva plug-ins. All this is not difficult to imagine.

4. Second order ambient intelligence

Beyond progress in the above mentioned technical and social aspects of AmI, there will be new interpretations of 'ambientness'. The word ambient carries a qualitative aspect of environment beyond living spaces. The ambient includes the air, water, atmosphere, forests, deserts and glaciers, not just buildings. It includes the myriad lifeforms that make the less structured environment their abode. AmI of the future might design for new forms of engagement with our surroundings, not just for convenience and utility, not just for pleasure and entertainment, but as novel forms of experience, curiosity and engagement. AmI might attempt to combine the worlds of synthetic systems with living systems. AmI might attempt to design for experiences through joint machine human cognition that neither humans nor machines alone are capable of. This is a strange AmI indeed. Inspired by historical precedents in cybernetics, I would like to call it *second order ambient intelligence*. As opposed to second order cybernetics, however, second order AmI would remain, in addition to a conceptual program, a technical practice and be spared the sad fate suffered by second order cybernetics that failed to find viable methods for implementing its ideas.

4.1. Time design

Second order AmI will develop a new way of representing time and duration. Time and duration representation are tricky issues for database designers today [1,21]. Second order AmI might need to consider time, and physical time [13], anew in order to become slow and purposeful. Time design in computers today and first order AmI is dictated by cyclical clocks; actions occur as a function of a beat that orchestrates the rest of the machine. Several approaches have been developed to represent events and sequence of events in homes. The iRoom at Stanford University defined to this purpose the event heap [14] to coordinate access to information resources that unfold on a human time scale. Combi and Rossato have proposed working with time-sensor granularities [11] to represent and reason on arbitrary (linear) temporal events. However, duration, the kind of time sleepy dogs and contemplative humans know of, is not part of the current computation model. While some temporal reasoning systems are capable of representing durative events [3], the duration concept is based on linear time models with discrete time granules.

4.1.1. Computing and duration

Waiting in a computer means cycling no operation events. A clocked computer (and the AmI system built upon it) that waits is like a person on a treadmill waiting for the mandated workout to end. What about slow events? What about events one hardly notices, that accumulate over time? What about the ability to do absolutely nothing, and how about the ability to do this for long periods of time as in geological time and then to emerge from this hibernation, fit to learn whatever the new environment might offer? This is a new ambientness, and it is not only an energy problem and an algorithm problem, but a time design problem. How would one represent such an event to an AmI system? Advances in asynchronous computing may help in finding more varied approaches to duration representation. After all, it is still not quite sure whether time exists at all [18].

Clockless computing might prove in itself too small a change to generate viable new temporalities that we can experience and appreciate. Electricity might have to make way for other modes of information transmission. Optical computing may be able to generate an 'off' state, one of darkness and nothingness [15], that electro-magnetic fields generated by electric currents prevent [9]. Regardless of the actual technical approaches that will prove themselves viable, time design will be an important part of second order AmI. Maybe there will be a way to make AmI compatible with Bergson's intuitive time and duration [4].

And with new forms of temporal representation we can imagine new ways of remembering. Second order AmI should be more like a good bottle of wine than a new gadget. It should age well. AmI should strive to make a new house more interesting a place to live in than an old house. The walls of a second order AmI smart house should distinguish our walking patterns from those of our neighbors and those who lived in the house before we did. Deep collective memory; a record keeping people are no longer performing, could become one of AmI's important responsibilities. It may open new and unusual ways of knowing and remembering.

4.1.2. Temporary autonomous ambient intelligence zones

Maybe we will see in the wake of such new time design opportunities new pairings of time-event combinations. Second order AmI will take cues not only from its successful first order predecessor, but also from knowledge from other fields. Hakim Bey's tem-

porary autonomous zone (TAZ) [5], might be a candidate for time-event design in second order AmI. TAZ is a temporary space-event that eludes formal structures of control. Bey's TAZ is focused on temporary non-hierarchical social relationships (in all its flavors). For AmI, TAZ-like affordance could translate into forms of temporal-event adaptiveness. AmI-TAZ could generate anti-noise around a house with a raving party all the while listening in on the barking dogs in the neighborhood and ordering taxis to the house just when the party dies down. TAZ is most interesting in creating free spaces without making permanent structures that by necessity of permanence enforce new forms of control and constraint. As such AmI-TAZ could create new freedoms not from the drudgery of work but from technologies that have replaced the drudgeries of work. AmI-TAZ events could be coupled with spaces that filter out electro-magnetic waves for new formulations of temporal respite from information overload. The monastery of the future will not need walls.

4.2. Inclusive ambient intelligence

Second order AmI should seek qualitative change. Second order AmI should design for small and specific situations while considering a global perspective. It must consider the costs, obvious and hidden, in its ambitious projects. It should provide not just for the well to do, but also for the underprivileged. Small AmI designed for the less than well-to-do can be socially responsible and profitable at once [22]. Second order AmI is a powerful technology cocktail; it has global scope in a networked world, and it must act accordingly.

4.3. Ambient intelligence with other species

Second order AmI might consider expanding the interaction equation beyond established human-machine interaction in radical ways. This seems plausible as sensors systems already exist that can see beyond our limited visual spectrum and listen in on audio signals far beyond our own limits. Not only does this allow us to watch out for alien life forms in remote places [2], but it allows us to watch and listen to life forms in our own AmI backyard. Smart systems that deserve the term should attempt to listen to those who seem to be saying nothing and find some meaning in it as Uexküll [23] suggested.

AmI designed to accomodate other species can teach us something about ourselves. Imagine a geothermal installation that generates warm water for a house. Image that the sensors in the ground would also listen to the insects and worms working their way in the soil. Imagine how we might think differently about the dirt if we only had some decent transmission from the underground. Imagine how differently urbanites would think about farming if their gadgets were designed to watch and listen to farm animals [7] they feed on. While first order AmI will make our lives easier, more comfortable, and attempt to make invasive technologies ethically acceptable and more socially just [8], second order AmI would, in my imagination, tell us things we do not know and make manifest what we take for granted. Imagine having a next generation listening system in your backyard that parses birds wild chattering before they leave on their migration flights southbound for the northern winter; imagine the same system at the destination in the southern hemisphere informing us of how many birds from that flock arrived and what they were feeding on. That would be ambient intelligence.

4.4. Engaged ambient intelligence

Second order AmI might also be endowed with a sense of responsibility, proactive responsibility for the good of planet, enacted by machines. There is no need to stipulate the impossible; machines need not know ex nihilio what to do. People should deliver the framework. Research in Human Computation and Participatory Design [6] is delivering some heuristics for such processes.

Imagine a distributed sensor network in the Atlantic ocean that recorded weather data and kept track of maritime traffic, but also listened to whale song and diverted ocean traffic when whales are in the vicinity and warned them (in their language) if the diversion failed with enough lead time to allow for escape. Imagine a similar system that tracked all those ocean faring vessels dumping toxic cargo into the ocean and sent customers of the goods produced in that process image evidence of the crimes in flagranti. Now that would be ambient intelligence, with a vengeance.

5. Towards second order ambient intelligence

Second order AmI is a technical and a political challenge at once. Advances in time design will be important as well as advances in robust reading and interpretation of actions performed not only by humans

but other species. Energy problems in remote and distributed sensing networks will persist until battery energy densities are substantially increased and toxicity decreased [10]. But second order ambient intelligence is not just a technical issue. Politically, there must be a will to move AmI in the above sketched directions. Market forces can help - indeed they are helping in the domain of privacy design and environmental impact, for example. Much more is necessary, however. We will need to invest heavily in the design of transparent systems, systems that are not only open to additions and modification, but open to scrutiny; ambient intelligence you can trust in your sleep but still query when in doubt. We will need new forms of literacy and snobbishness to discern the various flavors of AmI systems. Open calls for international competitions in the design of AmI systems for public use can help generate new ideas and foster public participation. Selective and differentiated AmI concepts will bring forth ever more refined ways of *being informed*. This must include the acceptance of new forms of responsibility for the management of data. We will need a new charta of civic responsibility vis-a-vis our data bodies. Data treatment and control will join water and waste treatment as services we expect modern civic societies to organize and reliably maintain. We must succeed in finding ways to use the best AmI can offer while preventing the worst it can generate from taking hold. Alternatives are too ugly to settle for.

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