AMBIENT INTELLIGENCE

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A Novel Paradigm

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*To a better and simpler
future!*

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Preface

If the space around us could adapt to our needs and intentions, then our lives would be much simpler. We would have to spend less time on our daily chores, we would be more productive and, hopefully, we would live in a less worrisome and, most likely, more secure world.

Ideally, it would be great if we could live our lives in environments able to commune with us. In Star Trek, the generic user not only can dialogue with a computer, but can also shape the environment - the *holodeck* - to suit their needs. Undoubtedly we are still far from such a futuristic era, most likely we will not live long to witness a Star Trek world, but we can push forward science and technology. However, in order to progress we can not simply and blindly rely on technology, we must develop interdisciplinary methods encompassing all aspects of our life to develop intelligent solutions, user centric, able to understand us and our lifestyle and activities. We will most likely need to design new methods for learning, adapting to specific moments in time, environmental and personal conditions. We will need to find new ways to combine science, technology, art and, above all, cognitive and psychological studies, to devise complete solutions; not simply working ones, operating to better the space around us.

Current technological advances have made giant leaps forward, but they are still too intrusive and passive. The monitoring of public and private spaces usually impinges on our privacy and in some cases barely adheres to the local laws (some European countries have very strict privacy laws on video data and information, for instance). So, interdisciplinary solutions will have to be adopted to include legal and ethical issues to generate solutions commensurate to all of us, as citizens of a modern and democratic society.

Across the Ocean, back in the 90's, the Americans introduced the concept of smart rooms, the European Community responded a decade later with the paradigm of Ambient Intelligence. Ambient Intelligence (abbreviated AmI), is wider in scope, even though some of the ideas were inspired by the smart room concept. Smart Rooms were introduced to offer a new solution to the human-machine interface problem. AmI goes well beyond this, encouraging intelligent systems where they cease to exist, or gracefully disappears into the

background. AmI promotes pervasive, distributed technology, not intrusive, but always present. A clear analogy is electricity: it is ever-present and widely used, but we do not think about it, and most of the time we are not aware of it. AmI intends to provide design criteria for an intelligent infrastructure; intelligent, not only because it can interpret our actions and intentions, but also because it can, more or less interactively, change our environment to help us with transparent solutions.

The last decades have witnessed major advances in science and technology, sufficient to make part of the AmI dream possible. Digital communication and wireless communication are most likely the technologies that have changed our lives most profoundly. The Internet is the clearest example. Such technologies have indeed helped us but they have also generated new problems. For instance the Internet can be seen as a communing means, but it can also be interpreted as a bundle of technologies making more difficult, if not impossible, natural human interaction. AmI wishes to introduce new ways of communicating between humans and machines, removing hurdles created by interfaces, and introducing more direct and intuitive modes of communication.

Writing a book on AmI, including or even touching all the aspects that the paradigm entails would be impossible. We as editors, wish to give the perspective of Computer Vision practitioners who have been working in the field for at least a decade and who are excited by the prospect of entertaining new horizons, pushing the current state of the art of machine vision and combining commonly used methods with available and fascinating techniques borrowed from other disciplines. Whoever will read this collection might be a little disappointed, because it has a strong technological slant and it relies on some mathematical, statistical and artificial intelligence techniques - computer vision being one of them. To the disappointed we wish to convey that we have started down a new road, and we have to learn how to bridge the gap, but we are neither scared nor worried to explore it and this volume is meant to be only the first step towards a long journey that will help us to reach some important goals.

PAOLO REMAGNINO, GIAN LUCA FORESTI AND TIM ELLIS

Foreword

Ambient Intelligence technology presents us with a huge challenge in the 21st century: it offers the creation of an environment which is responsive to the activities and presence of people. What does this mean and what kind of world does this create? Designing for this type of environment needs a new approach: instead of thinking of technology as a resource inside a 'black box', the meaning of ambient intelligence is that a distributed network presents facilities to people wherever they are in multiple forms which are offered through old, new and hybrid interfaces. This technology therefore presents a number of challenges: - how can we represent the full functionality of a networked responsive system though a local interface? - how can we design the tangible interfaces in the 'real world' to be hybrid representatives of a virtual and physical 'border' condition? - how can we ensure the trustworthiness and security of a system in which people delegate responsibility to a diffused network?

The greatest challenge is therefore not in the technology itself but in the cultural manifestations and functions of the technology. The distribution of computation, communication and information across everyday environments such as the home, the workplace, the car and the shopping centre, means that a population of networked technical devices needs to be designed in such a way that they are useful, meaningful, and dependable for the people who use them. As they become connected to form communities of devices and ecologies of systems, accessing and sharing information, they have to remain understandable and dependable as they scale up and start to represent access to increasing amounts of functionality and content. And so the issue becomes one of complexity: exponential complexity in terms of the way that mediating objects are linked together: at the level of the user, the environment and the system.

The research challenges for Ambient Intelligence are therefore multiple: the programming of the system dynamics, the development of appropriate technological capabilities, the design of culturally relevant systems and the understanding of human aspirations. We need to ensure that Ambient Intelligence research includes design and cultural factors in the innovation process, because the problems and opportunities posed by such a technology are in fact, largely cultural and psychological: we need to know how to customise technology in

such a way that it is useful to many different types of people and not just those whom we can define as the 'technological elite' within western society: its 'lead users'. The ambition for this technology is that it is available in all environments - in which case, it has to be able to 'mould' itself to local conditions. This adaptivity can only be effected when we know how different people think and experience their world, how they want to spend their time, in what ways they may wish to work and why they may want to use this type of technology. In other words, we have to be able to customise from the level of global system to individual user, whatever their age or cultural background, This seemingly impossible requirement must be the starting point for the research on Ambient Intelligence, because otherwise the results will not be intelligent enough. Even worse, the results will be delivered ' preloaded' with inappropriate cultural assumptions and design forms - in which case, they will be useless.

In the European Commission's research programme 'Connected Community' I proposed that 'community as database' be a research theme for the projects which would be launched. The assumption was that human resources are the most intelligent on the planet, and it would therefore make sense to design technological systems to access 'real time' human resources rather than information in a computer database. We can develop Ambient Intelligence solutions that allow us to access the collective intelligence and experience offered as a human resource - whether they are retired teachers who can help a child with homework, or an unemployed person able to help with gardening, or a network of elderly people caring for one another - in all cases, the technology facilitates human intervention and action. This is the route that ensures that technology is designed with people in mind - that it is proposed as a 'tool' rather than a 'solution' and that it facilitates and enables human creativity rather than only automating functions and focussing exclusively on efficiency and productivity.

The worlds that we live in are very far from technological dreams such as 'the paperless office', the 'smart home' and the robot cities of fiction. We live in emotional, cluttered landscapes at home and at work, and we seem to like it this way. We construct environments which support our emotional and spiritual needs and not just our physiological needs. Ambient Intelligence technology must perform usefully within these environments, and be sophisticated enough to recognise and support local cultural values and individual needs at all levels of human aspiration. In my own work I have concentrated on the 'augmentation of the human' rather than the creation of autonomous technology. The ubiquity of the mobile telephone is perhaps the real forefront of distributed computing, and there we see the user as publisher - or 'micropublisher' - of texts and visual material. We can assume that this trend will continue and we will see the role of the user being transformed into one of producer, director, publisher and entrepreneur - facilitated by an Ambient Intelligence environment which promotes this level of empowerment.

I am proposing that for Ambient Intelligence Research to make a difference and effect a paradigm shift in the role of technology in our everyday lives, we need to form interdisciplinary teams of cultural anthropologists, psychologists, designers and research scientists working together to create 'open tools' that enable the individual and the collective to achieve their goals. Otherwise, we will add a new layer of unsophisticated complexity on top of the current 'digital divide' and will deliver technologically and culturally determined solutions to a disappointed and disenfranchised public. Instead, we can take up the challenge that Ambient Intelligence offers us and construct environments which synergise social and technological behaviours and contribute to human wellbeing. The 'palette' of technologies such as computer vision, speech recognition, artificial intelligence, robotics, embedded intelligence, machine learning, and distributed computing embrace a diversity of 'dynamic materials' that we can use to construct ecologies and communities of socio-technical systems. This book is a timely and valuable contribution to this discourse in the wider community of Ambient Intelligence researchers and practitioners.

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