

Human-Harmonized Information Technology,
Volume 1

Toyoaki Nishida
Editor

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Vertical Impact

 Springer

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Dedicated to the late Prof. Yoh'ichi Tohkura

Forewords

The Japan Science and Technology Agency (JST) is a major organization in Japan to promote science and technology policies and to provide research funds to researchers mainly in academia in order to support innovative science and technology. CREST is one of the funding programs promoted by JST, and in the field of Information and Communications Technologies, eight research areas are ongoing, one of which is “Creation of Human-Harmonized Information Technology for Convivial Society.” Under the Research Supervisor, Prof. Toyoaki Nishida, who took over from the late Prof. Yoh’ichi Tohkura, 17 projects have been initiated. I have served as a research advisor for two different areas, one of which is this area. There are 17 highly advanced projects selected in the area. I noted as an advisor that the important point of projects in this area is to focus on the technologies for “convivial society.” There have been several element technologies studied up to now such as virtual reality, augmented reality, robotics, sensing technologies, and so on. These technologies have been rapidly progressing, but in order to realize a convivial society, these element technologies should be combined and harmonized based on the requirements for convivial societies. The chapters in this publication can contribute to the creation of new theories, new architecture, new systems, and the invention of advanced applications to provide convivial societies. Such societies are required not only in the 2020s and 2030s, but in the 2040s, when “singularity of artificial intelligence” is envisaged to be a reality.

Tomonori Aoyama
Professor Emeritus, The University of Tokyo
Visiting Professor, Keio University

A harmonization between human beings and machines is becoming a more important function in daily life. The human-harmonized information technology that can understand a human’s internal intentions will be able to realize healthy and cultured living and good preparation for an aged society. Some interesting themes of the human-machine harmonization have been explored by Prof. Tohkura and

researchers in a CREST project. Chapters appearing in this book bring fascinating results not only to the harmonized society but also to Cyber Physical Systems and the Internet of Things.

Kazuo Asakawa
Fujitsu Laboratories, Ltd.

When the late Yoh'ichi Tohkura, Ph.D., started a field of research with the theme of harmony between human beings and the information environment, “information circulation” was emphasized as a key word that must never be forgotten. It not only referred to the processing of information but also pointed out the importance of feedback of the processed results to human beings. It expresses the idea that we should consider comprehensively the nature of the information environment being created, including “how” is “what feedback” given and whether the results will be useful at all. This book is the first to discuss the information circulation from three perspectives—with regard to people, information, and machines. The research findings introduced here serve as a persuasive guide to the design of our information society.

Eisaku Maeda
Vice President, Head of NTT Communication Science Laboratories

Technological singularity is widely considered as an Artificial Intelligence disaster triggered by highly advanced information technology. This idea of an exclusive relationship between human beings and machines is fascinating and seems to be a relationship inspired by the old story of Frankenstein’s monster. The concept of human–machine harmonization, advocated by Prof. Tohkura, considers both human beings and machines as the necessary parts of the “information circulatory system” in human-harmonized information technology. This book predicts the future appearance of technological singularity that would not exclude humans; it will create a harmonious relationship between humans and machines in the information circulatory system. In the future, humanity will have its embodiment harmonized between humans and machines.

Taro Maeda
Professor, Graduate School of Information Science and Technology, Osaka
University/Center for Information and Neural Networks, NICT

This book guides the reader through cutting-edge research trends anticipating the way in which humans will live their lives in the rich information environments of the near future, receiving intellectual assistance while they work, study, eat, and have fun. The book’s chapters cover a wide range of topics, but the reader may find that they come together under a coherent idea of looking ahead into the future. The entirety of this book is related to a research field of JST CREST, one of the most prestigious research grant schemes in Japan. This fact alone, however, does not

fully account for the impression the book strikes on its readers. I am fond of the late Prof. Tohkura's stance in which a JST CREST research area should virtually function as a national research institute, with the research supervisor acting as its director. This was undoubtedly his role as the first research supervisor of the "Creation of Human-Harmonized Information Technology for Convivial Society" research area. From the beginning, he clearly showed his views regarding the definition of a convivial society, as well as how human-harmonized information technologies should be in such societies. In this regard, he emphasized that an information environment should enhance humans' intellectual capabilities. He showed his strong and talented leadership and excellent discernment while selecting all the research directors, who are responsible for each of the chapters in this book now with the prominent research outcomes. Moreover, he, as well as his successor, Prof. Nishida, continuously encouraged the research directors to not only pursue their original research objectives, but also to actively seek the opportunity to discuss and collaborate in joint research projects with other colleagues, in particular those working in this research area. I can say that those stances resulted in great success. I am sure the reader will enjoy going through every chapter.

Yôiti Suzuki

Professor, Research Institute of Electrical Communication, Tohoku University

Japan is becoming a super-aged society ahead of the rest of the world, and with it, the number of persons who have cognitive disabilities is sharply increasing. Moreover, persons who have developed visual or auditory function disorders or communication disorders in their youth must keep living in a society while burdened with a major handicap. Information technology (IT) compensates for weaknesses in human information processing, and the hope has been that IT will serve as a tool to assist those with language and/or communication disorders. While it is said that current artificial intelligence (AI) has functions that exceed human potential, we must wonder if it has become a technology that is beneficial to everyone. There is also the chance that globalization of useful IT will even lead to the homogenization of human thoughts and sensitiveness.

This project does not simply aim for IT that exceeds human ability for intelligence, but explores the underlying potential and diverse functions of humans while examining what IT should be, such as AI, for harnessing the potential and diverse functions of humans. Through my own research I have experienced how the underlying potential and diverse functions of humans can often surface for the first time after persons develop a physical disability. Persons who have developed language and/or communication disorders will try to converse through gestures or tactile means, while elderly persons who have developed cognitive impairments will increasingly try to convey something through facial expressions and gestures. However, that is insufficient to properly communicate with others and leads to social isolation, and society has yet to come up with a good approach for how to assist these people.

Fortunately, the researchers of the themes in this project have taken on the challenge of elucidating information on the processing function that lies deep within the brain; not just “intelligence”, but also “emotion” and “consciousness” that lie in the background of intelligence. Furthermore, several of the themes feature highly creative approaches, such as discovering the possibilities of humans from new perspectives and helping to revive the aesthetic sense and spiritual cry that lie deep within the brain during the course of evolution. I believe that these approaches will contribute greatly to revealing and fostering human creativity, which are major goals of the project.

This book summarizes the results to date of this project. For example, it describes IT that grasps meanings conveyed by tactile means or movements in addition to words, whereby a computer answers using expressions with universal understanding. Persons with cognitive impairments and those with language and/or communication disorders have been waiting for this technology, which will become highly useful as a tool to promote their social participation. Additionally, research that reveals and fosters human creativity could give rise to various arts, such as new and yet familiar-sounding music that crosses racial and ethnic boundaries. This will give the joy of creativity to humans and give new purpose to living. This book describes how AI and IT should be developed, so that humans can truly understand each other and share the joy of creativity, and describes many hints and approaches for realizing this.

Professor Yoh'ichi Tohkura, the program officer for this project until 2014, was a friend of mine for more than 40 years. We shared the same dream of creating IT that is truly useful to humans, the kind described in this book. I hope that those of you who also wish to realize the same dream will enjoy this book.

Tohru Ifukube
Professor Emeritus, Institute of Gerontology, The University of Tokyo

Preface

The late Prof. Yoh'ichi Tohkura envisioned an information era in which information is used to achieve harmony for cultivating human and social potential, and proposed the idea of human-harmonized information technology. The vision was so fascinating that the Japan Science and Technology Agency (JST) decided to launch a EUR 40 million JST-CREST research area in FY2009 to substantiate a basic core of his grand idea in 8 years. Participated in by 17 research teams, the project has been actively working on building the human-harmonized information technology for significantly activating the inner power of individuals and the society for evolving creative life, and not just trying to passively follow their intentions. Although it was a profound sorrow that Prof. Tohkura passed away in December 2013 after intensively fostering the project in its infancy, the project kept growing after that tragedy and started to bear fruit.

This book is the first of two volumes that describe the major outcomes obtained from the JST-CREST research area on the creation of human-harmonized information technology for a convivial society, as delineated above. The challenge I tackled to assemble this book centered on uncovering not just hidden trails but also trunk highways, the untold philosophy, to restore the strategy of technical development toward a convivial society. To put it another way, I wanted to redraw a big picture that would tell why we need to develop a new technology for transforming the ongoing technical society into a convivial society, and moreover, exactly what difference and contribution we have been attempting to bring about by our human-harmonized information technology.

After nearly a couple of years of discussions, we have found that the idea of the human and social potential beautifully explains everything. Even though the current development of artificial intelligence would eventually release us from labors either physical or informational, the individuals and society will need to find new styles and ways of living for wellness in the new technology world. It is quite probable that we may have to overcome a great deal of suffering to reestablish a conciliation with technology, as the nature of our life and society to be brought about in a new AI-gear technology might be drastically different from the conventional one we

have been familiar with, and the change might be much faster and overwhelming than we might have thought. It is evident that people will need to find a nontraditional style of self-actualization and society will aspire to a new principle of endorsing harmony.

Human potential is the power of an individual that enables her or him to actively sustain an endeavor to achieve a goal in maintaining a social relationship with other people. It involves vision, activity, sustainability, empathy, ethics, humor, and aesthetic sense. Social potential is the power that a society of people possesses as a whole. It encompasses generosity, supportiveness, conviviality, diversity, connectedness, and innovativeness. We believe that human and social potentials complement each other to enable conviviality, and that Prof. Tohkura focused on human perception to explore the research into the human-harmonized information technology on the road toward the convivial society. The framework of the human-harmonized information technology centers on understanding and enhancing cognitive dynamics resulting in the interaction between pathos based on embodied perception and logos based on modern civilization.

First, we have been shedding light on high-level but often tacit sensations in the search for better scientific understanding and technological support. For example, we have found that a sensation of presence results from complex dynamics over multiple sensations and tactile information—for instance, a feeling of hugging plays a critical role in convincing us of a presence. We have identified some tacit non-verbal cues that help people a lot in dealing with interpersonal relationships. We have also found that overtrust may result from an unconscious dependence on tacit cues.

Second, we have been developing artificial systems that can recognize the world in the way humans do. These new artifacts are useful in building a common ground in human–artifact symbiosis, which may make human–artifact interaction both proficient and reliable. The haptic sensation is a relatively new area of research. Some research teams in our research area have worked on not only high-performance recognition and production but also on integrating haptic sensation techniques in a multi-modal interaction environment.

Third, we have worked on design and dissemination. Design is a key to applying technology to produce satisfaction in society. Design encompasses activities of inventing social activities to composing a solution to achieve a desired goal by combining existing solutions and negotiating with the users for a consensus possibly with compromises in return for benefits. We have exploited the state-of-the-art technology to design novel services ranging from information display to a life-long infrastructure for food. Disseminating a tool is an important contribution from research based on computer science. Dissemination has many aspects in common with design, as tools need to be designed generically so they can fit into many application scenes.

Finally, we placed much emphasis on longitudinal large-scale interactive display at public places such as the National Museum of Emerging Science and Innovation (Mirai-kan) as well as long-term sustained field trials, where we can not only reach out to a large number of people with a broad background but also learn directly or

indirectly from discussions on the spot where the technology is displayed. In this book, each contribution lays much weight on discussing the philosophy, concepts, and the implications underlying the project. The first volume, with the subtitle *Vertical Impact*, includes the nine works resulting from the projects launched in 2009–2010, while the second, with the subtitle *Horizontal Expansion*, the eight works from those launched in 2010–2011. Overall, the first concentrates more on basic perception, while the second more on compositional aspects.

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Toyoaki Nishida

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