



SUDHIR DIXIT  
RAMJEE PRASAD

# Human Bond COMMUNICATION

THE HOLY GRAIL OF HOLISTIC  
COMMUNICATION AND  
IMMERSIVE EXPERIENCE

WILEY

**This book examines the Internet of Things (IoT) from the perspective of the five types of human communication to allow more expressive and holistic sensory information exchange in the fields of sensors, wireless, physiology, biology, wearables, and the Internet**

The book focuses on all technologies and issues related to human bond communication. It includes use cases and business opportunities emanating from human-to-machine and machine-to-machine applications, interactions, and communication. Information and communications technologies have progressed rapidly in this millennium for people to exchange information using multimedia (speech, video/image, text), and the same has extended to the Internet of Things and machine-to-machine and machine-to-human communication. However, the ability to integrate the other remaining three sensory features, namely, olfactory (smell), gustatory (taste), and tactile (touch), in information transfer and replication to deliver "being there in-person" experiences is still far from reality. The authors use this book to accelerate the launch of a new era of novel products and services to disrupt the status quo of contemporary applications and services. In addition, the book:

- Describes the HBC field and its evolution and integration with wireless technology
- Covers emerging context of cloud and analytics in HBC, wearables, and personal/body area networks (PAN/BAN)
- Examines the convergence of many different fields, such as medicine, biology, chemistry, 5G wireless, and ICT with interdisciplinary solutions to holistic communication

**SUDHIR DIXIT** is cofounder and CEO of Skydoot, Inc. He is also the Director of Human Bond Communication at the recently founded CTIF Global Capsule (CGC) in Rome and is a Fellow and Evangelist of Basic Internet at the Basic Internet Foundation in Norway. He is a Life Fellow of IEEE and Fellow of IET and Fellow of IETE. He is on the editorial boards of IEEE's *Spectrum Magazine*, Cambridge University Press's *Wireless Essentials Series*, and Springer's *Wireless Personal Communications* journal. He is chairman of the Vision Committee and vice-chair of the Americas region of the Wireless World Research Forum (WWRF). He also chairs the IEEE ComSoc Sub-Technical Committee on Fiber and Wireless Convergence. With Wiley he has authored *WiFi, WiMAX and LTE Multi-hop Mesh Networks: Theory, Design, and Application Areas* (2013), has co-edited *Technologies for Home Networking* (2008), *Content Networking in the Mobile Internet* (2004), and *Next-Generation Optical Internet* (2004).

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Cover Design: Wiley  
Cover Image: © dem10/Gettyimages

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Also available  
as an e-book

9781119341338 电子与通信技术SJ



分类码: TN

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ISBN 978-1-119-34133-8



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The Holy Grail of Holistic Communication  
and Immersive Experience

*Edited by*

*Sudhir Dixit  
Ramjee Prasad*

**WILEY**

This edition first published 2017

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John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

*Editorial Office*

111 River Street, Hoboken, NJ 07030, USA

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*Library of Congress Cataloging-in-Publication Data*

Names: Dixit, Sudhir, editor. | Prasad, Ramjee, editor.

Title: Human bond communication : the holy grail of holistic communication and immersive experience / edited by Sudhir Dixit, Ramjee Prasad.

Description: Hoboken, NJ : John Wiley & Sons, 2017. | Includes bibliographical references and index.

Identifiers: LCCN 2016046268 (print) | LCCN 2017002987 (ebook) | ISBN 9781119341338 (cloth) | ISBN 9781119341468 (pdf) | ISBN 9781119341413 (epub)

Subjects: LCSH: Telecommunication systems. | Human-computer interaction. | Digital communications. | Information technology.

Classification: LCC TK5102.5 .H86 2017 (print) | LCC TK5102.5 (ebook) | DDC 621.38201—dc23  
LC record available at <https://lcn.loc.gov/2016046268>

Cover design by Wiley

Cover image: © dem10/gettyimages

Set in 10/12pt Warnock by SPi Global, Pondicherry, India

Printed in United States of America

10 9 8 7 6 5 4 3 2 1

**Human Bond Communication**



नैव किञ्चित् करमीति युक्तो मन्येत तत्त्ववित् ।  
पश्यन् शृण्वं स्पर्शम् जिघ्रन्श्नन् गच्छन् स्वपञ्च श्वसं ॥

प्रलपं विसृजन् गृहणं उन्मिषण निमिशन् अपि  
इन्द्रियाणीन्द्रियार्थेषु वर्तन्त इति धारयन् ॥

*Naiva kinchit karmiti yukto manyeta tattvit-vit  
Pashyan shunvan sparshan jigrhrann asnan gacchan svapan svasan*

*Pralapan visrijan grihnann unmishan nimishann api  
indriyaanindriyaarthesu vartanta iti dhaaryan*

One who knows the truth is always certain that it is the senses that are engaged in observations, like seeing, hearing, smelling, touching, and tasting and is the involuntary participant of the actions happening around, just like opening and closing of eyelids. Such observations are not the part of the ultimate knowledge, but, when a seeker looks beyond them, finds the ultimate truth.

—The Bhagavad Gita (5.8 and 5.9)





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Sudhir Dixit has 21 patents granted by the US PTO and has published over 200 papers and edited, coedited, or authored seven books (Wireless World in 2050 and Beyond: A Window into the Future (2016), Wi-Fi, WiMAX and LTE Multi-hop Mesh Networks by Wiley (2013), Globalization of Mobile and Wireless Communications by Springer (2011), Technologies for Home

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He is the Founder Editor in Chief of the Springer International Journal on Wireless Personal Communications. He is a member of the editorial board of other renowned international journals including those of River Publishers. Ramjee Prasad is Founder Cochair of the steering committees of many renowned annual international conferences, for example, Wireless Personal Multimedia Communications Symposium (WPMC) and Wireless VITAE and Global Wireless Summit (GWS).

He has published more than 30 books, 1000 plus journal and conference publications, and more than 15 patents and over 100 PhD graduates and a larger number of master’s students (over 250). Several of his students are today worldwide telecommunication leaders themselves.



## Preface

Applications today have been enriched with multimedia content consisting of audio, video, augmented reality and consistently progressing toward multidimensional rendering, such as stereo, 3D, ultrahigh definition, and fidelity. In parallel, the user interaction with the devices and applications is delivering engaging experience through voice, gestures, gaze, touch, and so on. Wearable devices and body sensors are continually being integrated with applications and user devices, such as a smartphone, remote control, and finding useful applications in healthcare and remote monitoring. Humans interact with applications and consume content through optical and auditory senses. But the understanding is incomplete in the absence of information from and about the other three sensory inputs, namely, olfactory (smell), gustatory (taste), and tactile (touch). This is because all five senses interestingly interact among themselves and the environment, such that being able to sense them, transmit them, and render them at the receiver can potentially deliver powerful experiences. This book on human bond communication (HBC) is about utilizing all five senses to allow more expressive and holistic sensory information exchange through communication techniques for more human sentiment centric communication. The overall outcome is for the human brain to be holistically cognitive of the subject of interest. This complete perceptive information is well exchanged among humans through these senses and, when collectively agreed, becomes knowledge. This is the first book of its kind to motivate research and innovation in holistic communication and to launch a new era of novel products and services to disrupt the status quo of contemporary applications and services that only deal with aural and optical capture, transmission, and rendering of information.

This book focuses on all technologies and issues related to HBC. It also includes the use cases and business opportunities emanating from human-to-machine and machine-to-machine applications, interactions, and communication. The chapters have been authored by the experts in the various fields, which collectively would make HBC possible.



This book is intended for graduate students, academic teachers, scholars, researchers, industry professionals, and software developers interested in the design and development of more engaging and holistic interaction experiences. This book will also be of great interest to casual readers not necessarily familiar with sensor and communication technologies. Therefore, the content is more descriptive and qualitative than theoretical in style of writing.

We thank the contributors of this book for their time and effort to make this book possible in a short period of time. We particularly acknowledge their patience and for always responding promptly to numerous requests for revising their chapters.

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January 2017

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