INDOOR AIR QUALITY ASSESSMENT FOR SMART ENVIRONMENTS

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Indoor Air Quality Assessment for Smart Environments

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Preface

Indoor air pollution (IAP) has been a rising concern for populations in developed and developing nations over the decades. Indoor air quality significantly influences people's general health and well-being since they spend most of their time inside, whether at home or work. According to health statistics, about 95% of the world's population suffers from one or more acute or chronic health concerns, making maintaining an active lifestyle difficult. Unfortunately, respiratory and cardiovascular diseases have become the primary concerns of the general public. Furthermore, most of this healthcare burden is driven by poor indoor air quality and repeated exposure to dangerous pollutant concentration levels. Pollution-related health problems can contribute to increased absenteeism and lost productivity worldwide.

Several researchers have made significant breakthroughs in air quality control to help building occupants live in healthy environments. These efforts have resulted in several breakthroughs in the development of smart environments. The active involvement of emerging technologies in this problem domain is expected to reduce pollution exposure and healthcare expenditures. The Internet of Things (IoT) and Wireless Sensor Networks (WSN)-based intelligent building management systems can assist with real-time monitoring of pollutants that cause poor indoor air quality (IAQ). These smart environmental monitoring systems can send out rapid notifications to occupants and automate ventilation as necessary. Furthermore, artificial intelligence AI-based models can aid in the timely forecasting of changing pollutant concentration levels, allowing building occupants to take necessary precautions to prevent harmful exposure. The unique mix of new technologies for IAQ management and evaluation in smart environments provides for immediate feedback and response. However, there are several obstacles to overcome in establishing intelligent environmental management solutions for commercial and residential buildings.

This book explores the IAQ problem domain while also highlighting the field's potential challenges, gaps, and opportunities. As the title suggests, it allows for assessing indoor air quality in smart environments using emerging technologies. The chapters in this book were written by various field experts from different corners of the world, and they address significant elements of IAQ management. The following is the outline of the book:

Chapter 1 explores the definition, current state of the art, and IoT/AI applications in the subject of indoor air quality. The authors cover IAQ management issues such as regulation, current measurement methodologies, and the possible integration of IoT and AI for indoor environment management. The book also describes how emerging technologies can promise outstanding returns to the communities in enhanced public health and well-being.

Chapter 2 focuses on the indoor environmental sensing technologies for occupant health and comfort. The research aims to provide an in-depth systematic review of various sensing technologies pertaining to indoor air quality, thermal conditions, acoustic comfort, odour, illumination, and vibrational disturbances. The chapter identified four potential research gaps in the problem domain, including cost-effectiveness, data

interface and privacy, sensor range and positioning, subjective interactions and occupant expectations.

Chapter 3 summarizes the computational aids, automated solutions, and machine learning-based methods to smart environmental management. The main goal of this study is to critically analyze the available technologies based on IoT, cloud computing, and fuzzy logic controllers to forecast IAQ levels. The authors explored a variety of sensors in the context of IAQ, including metal oxide semiconductors, electrochemical cells, and infrared modules.

Chapter 4 presented an experimental analysis and risk assessment for real-time IAQ monitoring based on Zigbee-based wireless smart devices. Using Xbee wireless transmission modules, a microcontroller board, and low-cost IAQ sensors, the author designed an IoT-based portable device. Several important IAQ metrics, such as $PM_{2.5}$, NO_2, SO_2, CO, and O_3, were used to evaluate the system's performance.

Chapter 5 provided a review in the context of IAQ while focusing on the observations made from green and smart hospitals. This chapter aims to determine the role of emerging technologies in creating a healthy indoor environment at green hospitals. This approach has the potential to encourage the development of green buildings in a variety of sectors, hence improving occupant comfort and well-being.

Chapter 6 performs an evaluation of Nano building products for reducing health risks in smart IAQ management. The authors in this chapter examined the potential effects of nanomaterials in sustainable building design and user health. This research sheds light on the need for appropriate nanomaterial selection for healthy building environments.

Chapter 7 describes the optimization options for household ventilation using an improved cookstove to enhance IAQ levels and public health. The authors reviewed several existing studies to gather scientific evidence in relation to the use of improved cookstoves to reduce the exposure of degraded air pollution levels for the building occupants.

We hope that the chapters included in this book will provide deep insights into the IAQ evaluation, management, and assessment using potential technologies. This book will work as a source of knowledge and information for upcoming researchers, field experts, policymakers, public health experts, and government agencies enhancing building air quality at different levels. It will also guide building occupants to take necessary measures to handle the built environment and ventilation arrangements.

This book would not have been accomplished without the contributions of the exceptional authors, professional reviewers, and IOS Press's supporting editorial staff. We congratulate all the contributors for their valuable efforts in submitting articles and presenting potential findings to the scientific world. Furthermore, we thank the reviewers for their timely evaluation, comments, feedback, and recommendations on submitted chapters. Finally, we would like to express our gratitude towards Dr. Juan Carlos Augusto, the book series editor, for his consistent and unwavering support throughout this journey.

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Chandigarh, India — Maitreyee Dutta
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About the Editors

Jagriti Saini

Jagriti Saini was born in Himachal Pradesh, district Mandi in 1992. She holds a Diploma in Electronics and Communication Engineering (2010) from GPW Kandaghat and completed her B. Tech in Electronics and Communication Engineering (2013) from HPU. She received a Master's Degree in Electronics and Communication Engineering from the National Institute of Technical Teacher's Training and Research (NITTTR), Chandigarh (Panjab University), India (2017). She was awarded a Gold Medal for securing the highest percentile in the entire university during her Master's Degree. Jagriti is currently pursuing her Ph.D. in Electronics and Communication Engineering from the National Institute of Technical Teacher's Training and Research (NITTTR), Chandigarh (Panjab University). She is also receiving an INSPIRE fellowship from the Department of Science and Technology (DST), India, for carrying out her research work. Her current research interests include Artificial Intelligence, Internet of Things, Environmental Monitoring, Indoor Air Quality Monitoring and Prediction, Healthcare Systems, e-Health, and Autonomous Systems. Her Ph.D. thesis entitled "Design and Development of Intelligent Indoor Air Quality Monitoring and Prediction System – Vayuveda" is mainly focused on developing cost-effective real-time monitoring and prediction system for indoor air quality management. She published more than 25 papers in reputed peer-reviewed international journals and conferences. Besides this, she is a frequent reviewer of journals and international conferences and works on several edited book projects.

Maitreyee Dutta

Maitreyee Dutta was born in Guwahati, India. She received a B.E. degree in electronics and communication engineering in 1993 from Guwahati University and was Gold Medalist in the same year. She obtained an M.E. degree in electronics and communication engineering, and a Ph.D. degree in the faculty in engineering from Panjab University. She is currently Professor and Head of Information Management and Emerging Engineering and Joint Professor in Computer Science and Engineering Department, National Institute of Technical Teachers' Training and Research, Chandigarh, India. She has more than 22 years of teaching experience. Her research interests include the Internet of Things, data security, IP networks, Internet, authorization, data privacy, Public Key encryption, pattern clustering, cloud computing, and data compression. She has more than 100 research publications in reputed journals and conferences. She completed two sponsored research projects – Establishment of Cyber Security Lab – funded by the Ministry of IT, Government of India, New Delhi, amounting to Rs. 45.65 lac and Establishment of Advanced Cyber Security Lab sponsored by MeitY, New Delhi, amounting to 62 lacs. One sponsored project Securing Billion of Things-SEBOT funded by All India Council of Technical Education, New Delhi, of amount Rs. 14.98 lacs is in progress.

Gonçalo Marques

Gonçalo Marques holds a Ph.D. in Computer Science Engineering and is a member of the Portuguese Engineering Association (Ordem dos Engenheiros). He is currently working as Assistant Professor lecturing courses on programming, multimedia, and database systems. Furthermore, he worked as a Software Engineer in the Innovation and Development unit of Groupe PSA automotive industry from 2016 to 2017 and in the IBM group from 2018 to 2019. His current research interests include the Internet of Things, Enhanced Living Environments, machine learning, e-health, telemedicine, medical and healthcare systems, indoor air quality monitoring and assessment, and wireless sensor networks. He has more than 80 publications in international journals and conferences, is a frequent reviewer of journals and international conferences, and is also involved in several edited books projects.

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Malka N. Halgamuge is a Senior Lecturer in Cybersecurity (Teaching & Research) at the Department of Computer Science and Information Technology, La Trobe University, Melbourne, Australia, since Dec 2021. From 2007–2021 Malka worked as a Researcher at the Department of Electrical and Electronic Engineering and Department of Infrastructure Engineering, The University of Melbourne. She completed her Ph.D. at the Department of Electrical and Electronic Engineering, The University of Melbourne, in 2007. Malka received the CAS President's International Fellowship from Chinese Academy of Sciences (CAS), Beijing (2017 & 2018), Incoming Leaders Fellowship from Australia India Institute (2016), Next Step Initiative Fellowship (2015), Australia-China Young Scientist Fellowship (2014), Dyason Fellowship to undertake research at Department of Epidemiology, University of California (UCLA), Los Angeles, USA (2013), Early Career Researcher (ECR) Award (2013) from Alexander von Humboldt Foundation. Two papers she co-authored with her Ph.D. students at The University of Melbourne received the Best Paper Award (2012) and Best Student Paper Award (2011). Malka received the Vice-Chancellor's Engagement Award (2010) and the Vice-Chancellor's Knowledge Transfer Award (2008) for her research at The University of Melbourne. She was also awarded the Solander Fellowship (2007 and 2008) for research collaboration with the Departments of Neurosurgery and Radiation Physics, Lund University, Sweden. She is passionate about research and teaching university students (Emerging Technology, Blockchain, IoT & Edge Security, ML & FL Solutions, and Bioelectromagnetics).

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