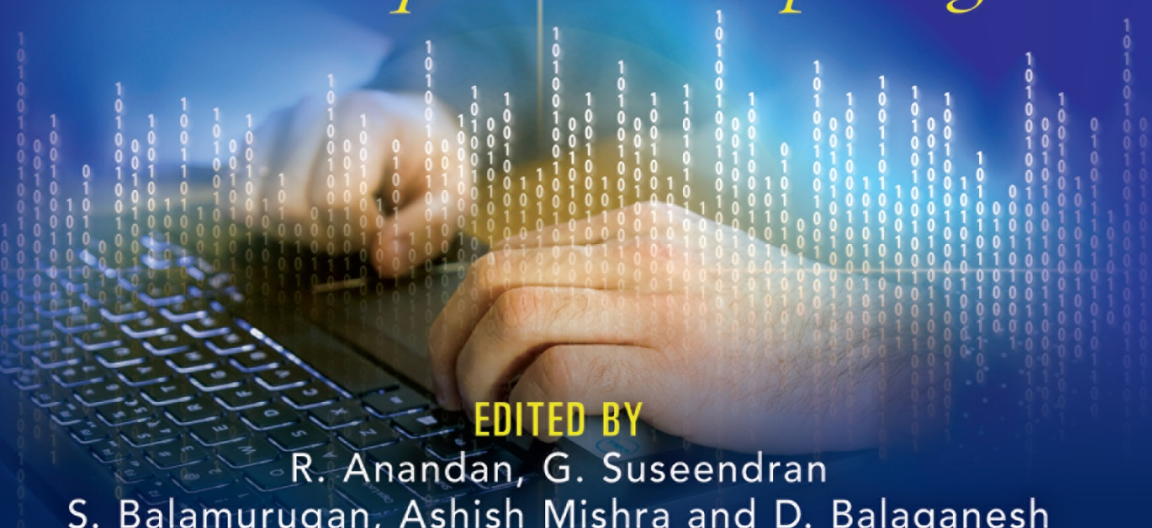
Artificial Intelligence and Soft Computing for Industrial Transformation

HUMAN COMMUNICATION TECHNOLOGY

Internet of Robotic Things and Ubiquitous Computing



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Artificial Intelligence and Soft Computing for Industrial Transformation

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Contents

Preface

It is with great pleasure that we introduce this book on "Human Communication Technology: Internet of Robotic Thing and Ubiquitous Computing". Our objective in writing it was to adopt advancements in the field and help disseminate results that cover a broad cross section of technical disciplines concerning recent applications and case studies in the areas of human communication technology, robotic intelligent systems, and ubiquitous computing among working professionals, academics and researchers. The book is also designed to provide students with a platform for exploring knowledge relating to human communication technology that will enable them to produce serviceable innocuous and purposeful systems using cutting-edge technology to yield computer systems with decent usability. In order to achieve these goals, developers must first attempt to understand the factors that determine how people use technology.

These new architectures, networking paradigms, trustworthy structures, and platforms for the integration of applications across various business and industrial domains are needed for the emergence of' intelligent things (static or mobile) in collaborative autonomous fleets. These new apps speed up the progress of paradigms of autonomous system design and the proliferation of the Internet of Robotic Things (IoRT). Collaborative robotic things can communicate with other things in the IoRT, learn independently, interact securely with the world, people and other things, and acquire characteristics that make them self-maintaining, self-aware, self-healing and fail-operational. Due to the ubiquitous nature of collaborative robotic things, the IoRT, which binds together the sensors and the objects of robotic things, is gaining popularity. Therefore, the information contained in the sixteen chapters of this book, as briefly described below, was chosen to provide readers with a better understanding of this interdisciplinary field.

– Chapter 1 describes how robots share information and operate in a common environment.

– Chapter 2 defines the BCI-based headsets developed with the architecture of the IoRT to analyze incoming EEG signals for the corresponding actions of human beings.

– Chapter 3 explains why automated verification and validation of IoRT systems warrant the functional safety and reliability characteristics of software using appropriate program verification techniques. These include automated model checking and theorem proving in combination with automated test frameworks for establishing independent testing in ubiquitous software environments using reduced manual resources and timelines to verify and validate systems with a higher degree of operational efficacy.

– Chapter 4 explains the sequential pattern mining process and fuzzy time interval sequential pattern mining using genetic algorithm (GA), pattern matching using similarity computation index (SCI), classification based on SCI value, and significant pattern evaluation process. The second part of the chapter shows how patients are assessed using a belief network automated via the IoRT.

– Chapter 5 describes the various Li-Fi technology applications used for man-to-machine and machine-to-machine communication. Li-Fi will be the future technology for short-range wireless communication.

– Chapter 6 highlights the computation process for monitoring human activity using human-centered computing. It focuses on the design, implementation, and evaluation of interactive information gathered from the technological system in relation to usable and accessible information gathering. The multimodal human communication interaction system is premeditated to receive communication from humans to provide improved results and an operative communication process.

– Chapter 7 showcases the automatic robotic systems designed and developed with a combination of computing, intelligence and the internet of things (IoT).

– Chapter 8 outlines the general layered architecture of an IoRT system with an emphasis on the various communication protocol choices available for each layer. The initial subsections summarize the latest developments in communication standards and data exchange protocols that tie robotics and the IoT together. There is a discussion of some of the prominent communication challenges in realizing an IoRT system along with the latest research solutions. A later subsection provides details about the open platforms available for developing IoRT solutions and also highlights the developments in the industrial sector that could bring such solutions to everyday life.

– Chapter 9 describes a real-time hazardous gas classification and management system using neural networks. The chapter begins by giving a

detailed view of the preparation of an input dataset from a sensor for an artificial neural network model that helps to classify and measure the concentration of gases and ends with network training using the dataset.

– Chapter 10 focuses on medical imaging research that uses a noninvasive diagnostic technique and many effective algorithms, such as gravitational search algorithms (GSAs), for optimization of modular neural networks (MNNs) in pattern recognition. In this chapter, a novel method known as the hierarchical elitism gene gravitational search algorithm is proposed.

– Chapter 11 proposes a machine learning algorithm that combines the IoT application areas. A basic aim of this chapter is to also analyze the different uses of machine learning in the IoT for healthcare, logistics, transportation and agriculture among others.

– Chapter 12 describes the time-variant adaptive techniques for feedback cancellation in hearing aids. The IoT-based bias analysis provides a statistical evaluation of the steady-state performance of an acoustic system and offers significant and robust feedback cancellation in the presence of varying environmental conditions.

– Chapter 13 applies the concepts of Industry 4.0 and Smart Cities Mission to pave the way to the concepts of Agriculture 4.0 and Smart Farming through the use of the IoT. With the evolution of the IoT, we have the ability to totally change the different phases of agriculture.

– Chapter 14 mainly focuses on the green computing practices used in combating COVID-19 in a study by the Institute of Health Sciences in Gaborone. This study investigated different literature reviews concerning green computing practices assisted by several theoretical models, such as the technology acceptance model, utilized to present an economical explanation of the components that define the adaptations, which are generally applicable to many utilization behaviors from different computing innovations.

– Chapter 15 lists the available technology of sensor, pervasive computing, and intelligent information processing widely used in body sensor networks (BSNs), which are a branch of wireless sensor networks (WSNs). These BSNs play an increasingly important role in the fields of medical treatment, social welfare and sports, and are changing the way humans use computers.

– Chapter 16 explains how the IoT, assisted by advanced electronic tools, offers the best ways of experiencing and responding to the outside world. However, at the same time, with the help of sensor information, new problems and obstacles will emerge as new application scenarios are envisaged. Therefore, this chapter investigates further developments, such

as the interoperability between heterogeneous devices and confidence in smart devices, to meet business and technical requirements such as validity, safety, and trust.

To conclude, we would like to extend our appreciation to our many colleagues. We also extend our sincere thanks to all the experts for providing preparatory comments on the book that will surely motivate the reader to read the topic. We also wish to thank the reviewers who took time to review this book, and are also very grateful to our family members for their patience, encouragement and understanding. Special thanks are also due to many individuals at Scrivener Publishing, whose talents and efforts made the publication of this book possible. Finally, any suggestions or feedback from readers to improve the text will be highly appreciated.

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Internet of Robotic Things: A New Architecture and Platform

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Abstract

IoT is an interconnection of internet-enhancing devices that increases the usage of internet. It provides a stable base for users to form communication with other devices. The linked devices will share data among themselves through network protocols. Internet of Things is a technological change among the Blockchain, AI, Cloud Computing, Machine Learning technologies with increasing speed to solve the problems.

The area of Cloud robotics includes cloud computing, Internet technologies and cloud storage. It enables robots to benefit from quick increases in online data transfer rates and reduces the maintenance, updates. By using cloud robotics, operation durations can be reduced and costs increased. Cloud robotics is used in a variety of areas, for example cloud computing, big data, distributed computing-Human and robotic constraints, such as service quality (QoS), physical infrastructure, privacy, jitter, multi-robotic management, etc.

In order to avoid limitations in cloud robotics we combine the Internet of Things with Cloud Robotics to provide smart, high performance, reliability, stability, cost-effectiveness and collaborative multi-robot networks. This paper describes how robots will share the information and operating in common environment. IoRT can make a solid base for implementing robotics in diverse applications. This work discusses about the architecture and platform of IoRT.

***Keywords*:** Amazon web services, real-time processing, robot operating system, cloud services, internet of robotic things, robotics

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1.1 Introduction

Internet of Things (IoT) is an integrated system of computers with special identifiers that is capable of transmitting data across a network without human interference. Smart home is a traditional control center, usually a handheld monitor of home appliances. A basic function is to switch the computer near or remotely on and off. In recent years the use of cellular networks has increased and is increasing rapidly.

A global data society system enables advanced automated administrations by interconnecting mechanical items that create, interoperable data and communications developments in distributed computing, distributed storage, etc. which is based on the benefits of hybrid cloud and joint administration. Internet creativity is focused on the advantages of hybrid cloud and public willingness to allow robots to take advantage of the tremendous processing, storage and exchange capabilities of today's cloud providers. At the same time spelling maintenance and refreshment overheads and improves flexibility on Custom Domain dependent middleware levels.

A robot is basically a machine which utilizes a mechanical stage that joins distinctive interconnected sensors, PCs and actuators to complete an activity. An automated stage encourages equipment deliberation, encourages programming, mechanical gadgets and electronic frameworks interface the executives. The multifaceted nature of the created conduct is limited by the handling intensity of the robot, which diminishes the first versatility of the robot, contingent upon the nearby equipment. The remote relocation of robot computation encourages robots to diminish weight, equipment expenses and battery use. Furthermore, it makes it simpler to access and store the information created. Distributed storage is one method of remotely getting to and putting away information.

Distributed computing alludes to a brought together cloud-based database of adaptable assets. The virtual machine, gadget or various cloud highlights, for example small scale administrations, is utilized as a cloud administration. Small scale administrations are cloud administrations running serverless from outsider providers, for example, Amazon, etc which abstracts the designer's equipment. Distributed computing empowers a wide scope of versatile preparing force and capacity ability to be utilized as focal usefulness for robots through conceptual equipment. An idea named cloud robotics [1] is developed by consolidating the two regions of mechanical autonomy with distributed computing.

Cloud apply autonomy is a cloud-based robot that utilizes the common pool of cloud assets. Cloud applies autonomy present incorporated highlights, designate capacity assets and procedure capacity to numerous

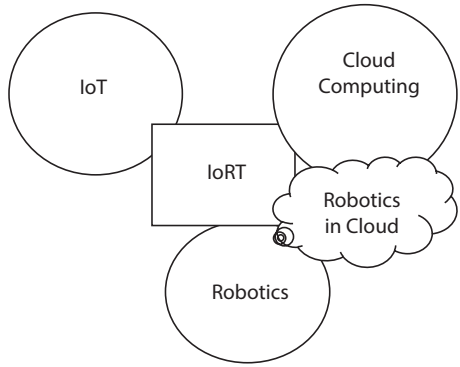

Figure 1.1 Description of the IoRT innovations.

robots. Anyway one significant element of cloud apply autonomy is the capacity of the robot to convey over the Internet utilizing normal correspondence innovation with different robots and devices. One answer for a worldwide system for availability is IoT.

IoT is an overall system that can connection and move information over the web to a group of gadgets known as things. This permits all members to convey utilizing [1] a typical correspondence innovation.

Subsequently, we intend to build up a novel idea, "Internet of Robotic Things" (IoRT) which is joined using these networks, as appeared in Figure 1.1. Internet of Robotic Things includes IoT, mechanical autonomy and distributed computing. Internet of Robotic Things attempts to interface propelled robots, utilizing existing and developing correspondences innovations, to trade interoperable information, as a general foundation.

1.1.1 Architecture

The architecture of IoRT is divided into five groups and each layer is represented in Figure 1.2. The protocol stack for each layer is represented in Figure 1.3.

(i) The hardware/robotic things layer,
(ii) The network layer,
(iii) The internet layer,
(iv) Infrastructure layer, and
(v) The application layer

i. Hardware Layer
The layer comprises robots, like vehicles, sensors, railings, submersible equipment, home equipment and mechanical sensors. The hardware layer

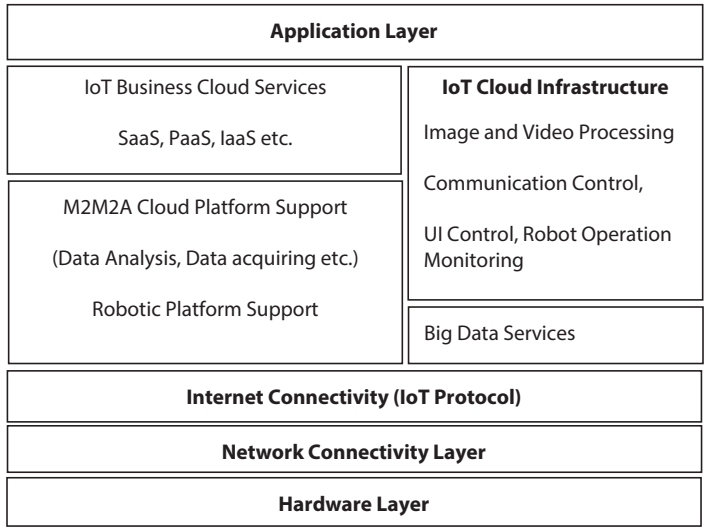

Figure 1.2 Conceptual model of IoRT Architecture.

is concealed in physical matters for using data in the layer above, namely the network layer.

ii. Network Layer
The second-base layer with system configurations is the network layer. This layer transmits data segments between frameworks as groups. Right when you message your buddy, this layer gives out source and objective IP conveys to the data parts. Your IP address is the source, and your partner's is the objective. Layer 3 similarly chooses the most ideal ways for data movement. Cell availability including 3G [3] and LTE/4G [4] are empowered in this layer, which enables smooth direct of transmission of data in the mechanical system [5–7] foundation in wider separation.

Application Layer	**CoAP**
Transport Layer	**UDP**
Network Layer/Routing	**IPv6, RPL**
Adaptation Layer	**6LoWPAN**
Datalink Layer	**MAC 802.15.4**
Physical Layer	**PHY 802.15.4**

Figure 1.3 Protocol stacks of IoT.

iii. Internet Layer
This layer excludes the shows that fulfill the inspiration driving keeping up interface states between the close by center points and that commonly use shows that rely upon the encompassing of bundles express to the association types. Such shows have a spot with the association layer. Web layer shows use IP-based groups. Distribute/purchase in training, multicast support, forward communications, products distributed structures, scatter the layout sorted out, provide protection for data chart displays, middleware lining, lightweight quarter-based computerization, and direct buying depends on the constantly embedded systems.

iv. Infrastructure Layer
IoT-based mechanical cloud stack is the most critical (cloud managerial, middleware, business process and information-oriented methodology) component of all network holding. The IoT-based mechanical cloud stack is a mix of five separate, but linked entities such as automated cloud storage, M2M2A cloud storage, IoT cloud management, Big Data and the technical base of the IoT cloud. Let us address each of them.

Cloud M2M2A is ready to use the worldview of MachineToMachine ToActuator as a robotic powered machine that anticipates being a basic machine to contribute to IoRT. M2M can be visualized as a variety of machines linked to a system that transfer data in and out without human interference and provides ideal computerized control. In order to bring real and virtual world together MachineToMachineToActuator [9] method uses helpful structures, where various sensors and mechanical inventions can be combined. In such sort of arrangements, pictured data administrations created by the sensors are between connected among themselves while figuring particular chain of activities/responses made to be performed by the robots. Out of many, information assortment, investigation, gadget the board, map cum climate information coordination and sensor information aggregation are of most significance. To lay it out simply, business fogs do serve the IoRT by allowing affiliations and makers of computerized structures to reduce their overhead of operational (business related) practices through an average layered technique where a wide scope of fundamental backings are given.

"A model intended to encourage the data society, empowering propelled benefits by interconnecting (physical and virtual) things dependent on, existing and developing, interoperable data and correspondence advancements through ennoblement of omnipresent, advantageous, on-request arrange access to a mutual pool of configurable figuring assets (e.g., systems, servers, stockpiling, applications, and administrations) that can be quickly provisioned and discharged with insignificant administration exertion or specialist

co-op collaboration that influence the need and heterogeneous availability issues of the client driven things in all around characterized style" [10].

In such situation, IoT cloud empowers automated frameworks to be enabled with a few administrations of which not many have been introduced, for example, picture handling, video preparing, area recognizable proof, correspondence control, organizing with SNS, mechanical conduct situations, and UI control as uncommon consideration.

v. The Application Layer
The application layer is the first most layers in the IoRT engineering which scatters the client experience by finding the tests performance over utilizing the mechanical autonomy. This layer lies over the organization divulgence layer. It is most vital layer in the designing loosening up from the client closes. It is the interface between the end devices and the framework. This layer is realized through a committed application at the contraption end. Like for a PC, application layer is executed by the program. It is the program which completes application layer shows like SMTP, FTP and HTTP. Same way, there is application layer shows demonstrated in setting to IoT as well.

1.1.1.1 Achievability of the Proposed Architecture

Let us first present the center attributes of IoRT engineering which is trailed by the highlights of the most diffused robots (automated framework), at that point IoT handling units, and cloud mechanical technology stages. IoT and mechanical technology are mutually embraced to oversee upgraded benefits in everyday human way of life.

1.1.1.2 Qualities of IoRT Architecture

Internet of Robotic Things gives a few notable highlights that are not quite the same as conventional mechanical technologies administrations, for example, cloud apply autonomy and arranged apply autonomy, which are summed up as underneath?

i. Similarity
The proposed IoRT engineering utilizes the interface named Web Service Description Language (WSDL), it endeavors to normalize a few correspondence interfaces conveyed for the design of IoRT. WSDL is incorporated to encourage some general correspondence between the independent robots (or automated frameworks) and along with different fragments of the IoRT.