# AMBIENT INTELLIGENCE AND INTERNET OF THINGS

## *Convergent Technologies*

Edited By
MD RASHID MAHMOOD
ROHIT RAJA
HARPREET KAUR
SANDEEP KUMAR
KAPIL KUMAR NAGWANSHI

Scrivener Publishing

WILEY

# Table of Contents

# List of Tables

Chapter 9



Chapter 11

# List of Illustrations

Chapter 3



Chapter 4

**Scrivener Publishing**
100 Cummings Center, Suite 541J
Beverly, MA 01915-6106

*Publishers at Scrivener*
Martin Scrivener (martin@scrivenerpublishing.com)
Phillip Carmical (pcarmical@scrivenerpublishing.com)

# Ambient Intelligence and Internet of Things

## Convergent Technologies

Edited by

**Md Rashid Mahmood**
**Rohit Raja**
**Harpreet Kaur**
**Sandeep Kumar**
**and**
**Kapil Kumar Nagwanshi**


WILEY

This edition first published 2023 by John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA and Scrivener Publishing LLC, 100 Cummings Center, Suite 541J, Beverly, MA 01915, USA

For more information about Scrivener publications please visit www.scrivenerpublishing.com.



**Wiley Global Headquarters**
111 River Street, Hoboken, NJ 07030, USA

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.



***Library of Congress Cataloging-in-Publication Data***

ISBN 978-1-119-82123-6

Cover image: Pixabay.Com
Cover design by Russell Richardson

# Preface

Working environments based on the emerging technologies of ambient intelligence (AmI) and the internet of things (IoT) are available for current and future use in a diverse field of applications. The AmI and IoT paradigms aim to help people achieve their daily goals by augmenting physical environments using networks of distributed devices, including sensors, actuators, and computational resources. Because AmI-IoT is the convergence of numerous technologies and associated research fields, it takes significant effort to integrate them for the purpose of making our lives easier. It is asserted that AmI is able to successfully analyze the vast amounts of contextual data obtained from such embedded sensors by employing a variety of artificial intelligence (AI) techniques, and that it will transparently and proactively change the environment to conform to the requirements of the user. Over a long period of time, the long-term research goals and implementation strategies could meet the design and application needs of a wide range of modern and real-time applications.

*Ambient Intelligence and Internet of Things: Convergent Technologies* provides comprehensive knowledge of AmI and the IoT along with practical applications. Since this book focuses on the fundamental structure of innovative cutting-edge AmI and IoT technologies, it will be of interest and use to students, academicians, researchers and industry professionals in the domain of AI, AmI and IoT. It will be a better option compared to the majority of books that are now available on the market because older publications rarely touch on contemporary applications of AmI and IoT.

We would like to thank all of the contributing authors who made a significant contribution to the creation of this peer-reviewed edited volume by giving of their time, effort, and insightful recommendations. The editors are also thankful to Scrivener Publishing and their team members for the opportunity to publish this volume. Lastly, we thank our family members for their love, support, encouragement, and patience during the entire period of this work.

**Dr. Md Rashid Mahmood**
**Dr. Rohit Raja**
**Dr. Harpreet Kaur**
**Dr. Sandeep Kumar**
**Dr. Kapil Kumar Nagwanshi**
October 2022

# 1
# Ambient Intelligence and Internet of Things: An Overview

**Md Rashid Mahmood[1]*, Harpreet Kaur[1], Manpreet Kaur[1], Rohit Raja[2] and Imran Ahmed Khan[3]**

*[1]Department of ECE, Guru Nanak Institutions Technical Campus, Hyderabad, India*

*[2]Department of IT, Guru Ghasidas Vishwavidyala, Bilaspur, India*

*[3]Department of ECE, Jamia Millia Islamia, New Delhi, India*

## *Abstract*

Ambient intelligence (AmI) is the ability of technology to make judgments and act on our behalf. AmI is a cutting-edge technology that has the potential to fundamentally alter the way we interact with machines and electronics in our environment. It does not ask the user questions but rather understands the context in which the user is operating. Ambient intelligence (AmI) uses sensors and devices in our homes and offices to gather information about the environment. The AmI system then makes inferences based on proximity, intent, and behavioral patterns. It reacts to the user via a smart device's elegantly built natural interface. The Internet of Things (IoT) is a network of web-connected smart gadgets that collect data from their surroundings and use it to make decisions about their own lives. Ambient intelligence refers to what occurs when various devices connect, and more specifically, what they learn from one another. Ambient computing is a new kind of relationship between computers and employees. It gathers information for us when we ask for it, or even

before we ask. Ambient intelligence aims to improve the way people and their environment interact with one another. Ambient intelligence (AI) is a subset of artificial intelligence (AI). Artificial intelligence mimics human cognitive processes such as perceiving, interpreting, and learning, among others. AmI is interlinked with the Internet of Things (IoT).

***Keywords*:** Ambient intelligence, Internet of Things, artificial intelligence, human computer interaction

# 1.1 Introduction

Ambient intelligence, often known as AmI, is the ability of technology to make judgments and act on our behalf while taking our preferences into consideration depending on the data accessible to it from all of the linked sensors and devices surrounding the user. AmI is a highly intelligent, widespread, and intuitive system. It does not ask the user questions but rather understands the context in which the user is operating. It does not make its physical presence known but instead performs actions that are suited to the user's needs. AmI is a cutting-edge technology that has the potential to fundamentally alter the way we interact with the machines and electronics in our environment. Ambient intelligence (AmI) is a term that is frequently used in conjunction with artificial intelligence (AI), the Internet of things (IoT), big data, machine learning (ML), networks, human-computer interaction (HCI), and pervasive, ubiquitous computing. On the other hand, artificial intelligence owes its success to the amazing growth of information and communication technology (ICTs) [1].

Intelligence is defined as the capacity to acquire knowledge and use it in novel settings. "Artificial" is anything created by humans, whereas "ambience" is what surrounds us. Additionally, we prefer to think of ambient intelligence

(AmI) is an artificial construct since the mechanisms underlying natural AmI are the focus of biology and sociology. Numerous artificial intelligence technologies developed by computers are based on the concept of replicating brain functioning and human intellect.

Everyday life is made up of a combination of hardware, software, user experience, and machine/human-machine interaction and learning. In other words, it is the act of employing a computer, a device having far-field communication capabilities, or an internet-enabled gadget without necessarily being aware of doing so. For example, we no longer need to use a desktop computer in order to operate a computer. They are unseen to us, function in sync with us, and provide an overall seamless experience.

AmI uses a variety of IoT sensors and devices in our homes and workplaces to gather information about the environment and user context. The acquired data is then processed by the AmI system. The processing and analysis of collected data are used to identify user proximity, state, intent and behavioral patterns in the AmI system. Thereafter, it makes inferences based on what it has learned so far, what it has seen before, and any patterns it notices. Once it has determined the appropriate course of action, it reacts to the user via the smart device’s elegantly built natural interface.

There are countless ways in which ambient intelligence may improve our lives. Regardless of where we are in the office, living room, shopping mall, or driving, we should always be mindful of our surroundings. Technology will serve as a constant companion. Our health monitoring devices can measure our blood pressure, so it tells us not to eat those high-cholesterol food items. It can be inconvenient to divert the route because it knows that there was an accident on our regular way to work. As soon

as we get home from work on a hot summer evening, it turns on the air conditioner to keep us cool.

Consider the following scenario: Peter returns home after a hectic day at work, and AmI systems assist him in relaxing.

- At his front entrance, Peter’s car is recognized by the system, and the parking door will open to allow him to enter it.
- At the next level, Peter is recognized by a facial recognition system, which allows him to enter his house.
- Peter’s facial expressions are captured by the AmI system, and the system determines that he is under stress.
- When Peter walks into the living room, the system automatically adjusts the lighting to suit his mood.
- AmI plays relaxing music from Peter’s music library, according to his preferences.
- The blinds and curtains are closed by AmI to keep the light from coming in from the windows.
- As soon as Peter gets on the couch, AmI plays a very important message from his wife. She says she will be home a little later from work.
- When I look at Peter’s calendar, it informs me that the conference call at 8.30 pm has been moved to 9:00 am tomorrow.
- AmI reminds Peter that his favourite reality show is on TV tonight by reading the TV schedule and asking if he wants to set a reminder for it.

Ambient intelligence (AmI) is interlinked with the Internet of Things (IoT). IoT refers to smart lighting, smart

transportation, smart homes, smart villages, smart grids, etc., among other things, and the way these items communicate. Ambient intelligence refers to what occurs when various devices connect, and more specifically, what they learn from one another.

The Internet of Things (IoT) is a network of web-connected smart gadgets that collect data from their surroundings and use it to make decisions about their own lives. Interactions between Internet of Things devices and a gateway or other cutting-edge devices transmit sensitive data that may be analyzed remotely or on-site. These gadgets communicate with one another and respond to each other's data. While people can communicate with robots, machines are capable of doing the majority of jobs without the need for human intervention.

It is expected that the Internet of Things will have an impact on society, the economy, and technology as it grows. Sensors and other ordinary items, as well as consumer devices, are becoming increasingly capable of storing and processing data. Despite this, there are a number of significant challenges that could hinder the Internet of Things from realizing its potential. The general public is well aware of the risks associated with Internet-connected gadgets, hacking, surveillance, and privacy violations. There is a new set of policy, legal, and development challenges that have evolved in recent years. The increasing use of Internet of Things (IoT) devices has the potential to transform our lives.

With the Internet of Things (IoT) devices such as Internet-enabled appliances, home automation components, and energy management gadgets, we are getting closer to having a smart house. In addition to other Internet-of-Things-enabled medical equipment, wearable fitness and health monitoring devices are transforming the way

healthcare is delivered. The disabled and the elderly will benefit the most from this technology, as it will increase their freedom and quality of life while simultaneously cutting their expenditures [2].

To exchange data and manage message traffic, an Internet of Things device connects directly to a cloud service, such as an application service provider, through a secure connection. When an Internet of Things device connects to a cloud service through an application-layer gateway (ALG), the device-to-gateway model is utilized. On local gateway devices, features like data translation and protocol encoding are accessible.

Using this paradigm, smart devices can communicate with one another without using the Internet Protocol (IP). A gateway is required for IPv4 devices and services to function effectively. This strategy is most frequently used to incorporate new smart gadgets into current parental control systems. In order to conduct an analysis, data from various sources can be integrated with smart object data from the cloud service. A business can even benefit from ambient computing. It can help it work more efficiently, remove unnecessary steps in processes, and collect, analyze, and actively learn from data.

When computers are used in the workplace, a new kind of relationship between employees and computers develops. It gathers information for us when we ask for it or even before we ask. Ambient computing already delivers sophisticated services like voice-assisted systems, chatbots, etc. [3].

## 1.2 Ambient Intelligent System

Figure 1.1 illustrates the ambience intelligence system for some specific application areas; it exhibits several smart

and intelligent systems that surround the user and make use of AI and ML technology. In this way, AmI is not a specific technology but rather a user's experience with the services supplied by such systems. Typically, the cost functions employed to optimize AmI systems are related to subjective human experience, which can be quantified only to a limited extent. As a result, in order to ensure the success of AI and AmI, we must find the optimal objective-cost functions that accurately capture the subjective human experience in AmI.

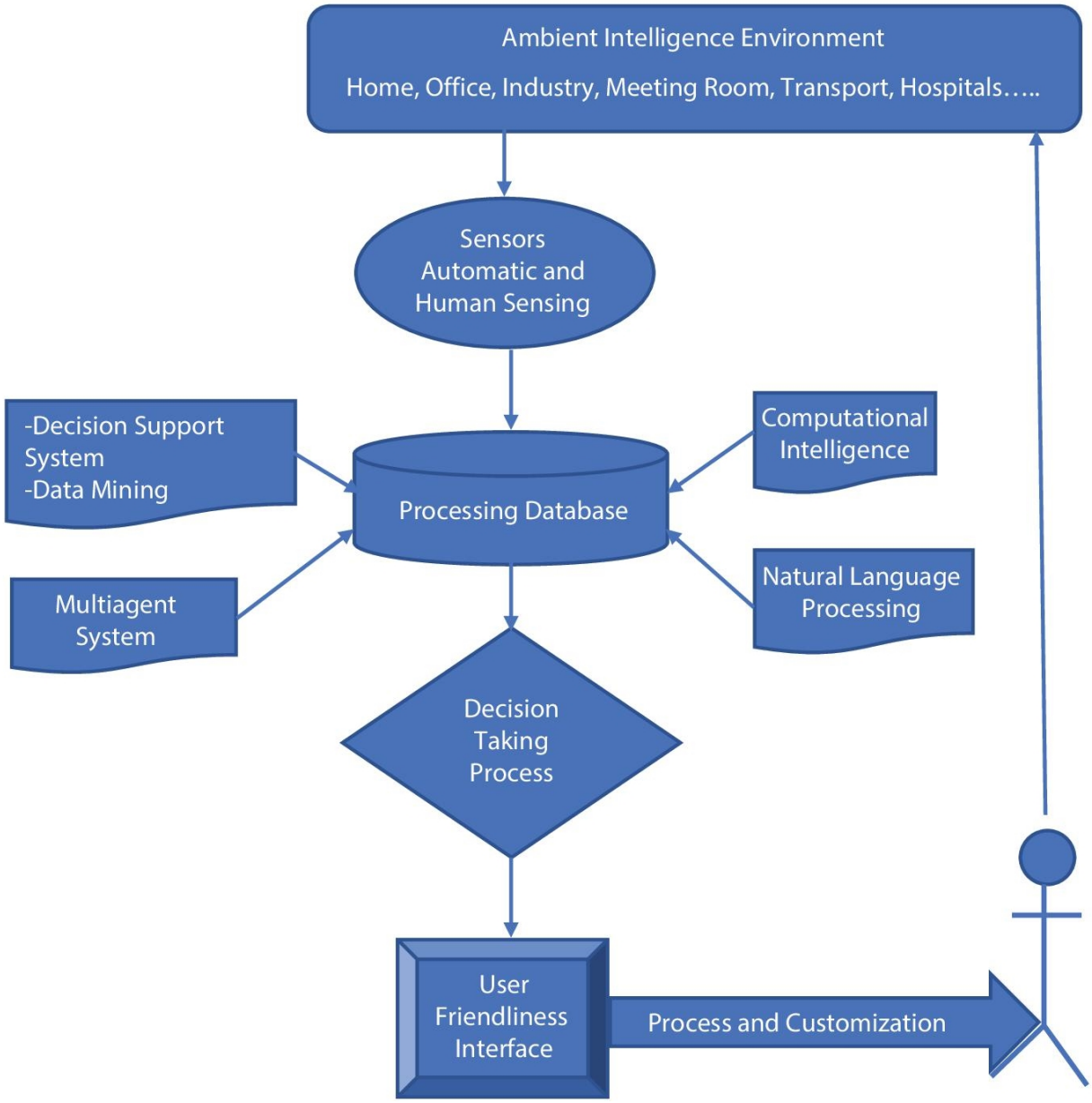


**Figure 1.1** Ambience intelligence system.

AI, also known as “machine intelligence” (MI), is the intelligence demonstrated by machines as opposed to the natural intelligence (NI) exhibited by humans and other animals. AI is a subset of artificial intelligence (AI). As a result, artificial intelligence mimics human cognitive processes such as perceiving, interpreting environmental input and learning, among others. Whenever robots demonstrate intelligence in their immediate environment,

this is referred to as “ambient intelligence.” Because of its emphasis on humans and the environment, AmI is much more than a collection of diverse artificial intelligence application domains; rather, it is a network of disparate areas that function together.

Ambient intelligence is an interdisciplinary topic of study that aims to improve the way people and their environments interact with one another. Ultimately, the goal of the area is to make our houses and places of employment more favourable to us. The concept of smart houses is just one example; it may be applied to hospitals, public transportation systems, industries, and a variety of other settings. Unlike the concept of a disappeared computer, AmI is compatible with it. Context awareness, human-centered computer interface design, and other aspects of pervasive and ubiquitous computing are all intertwined with the field of artificial intelligence [4].

## 1.3 Characteristics of AmI Systems

**Invisible:** Ambient computing occurs in the background. For example, in a commercial conference room setting, an AI system can gather data and take notes on a conversation without the participants’ being aware of it. Simultaneously, the camera and a speaker system can be adjusted to optimize image quality and focus on the person speaking.

**Easy to Implement:** Ambient computing is straightforward and simple to implement. Intelligent technologies are becoming more common in today’s communication environment. Now that consumers can connect via voice or text, they can select the mode of communication that is most convenient for them.

**Context-aware:** They identify a user and, if possible, the user’s present state and situational context. Systems and