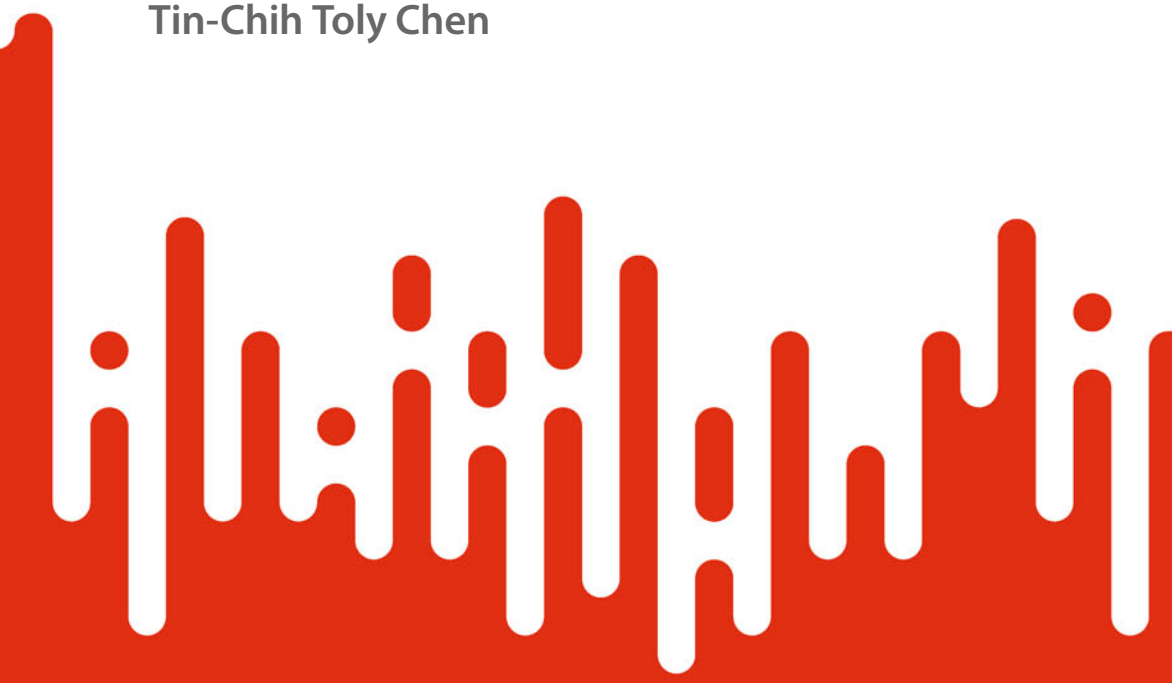
SpringerBriefs in Applied Sciences and Technology

Tin-Chih Toly Chen



Explainable Ambient Intelligence (XAmI)

Explainable Artificial Intelligence Applications in Smart Life

Springer

SpringerBriefs in Applied Sciences and Technology

SpringerBriefs present concise summaries of cutting-edge research and practical applications across a wide spectrum of fields. Featuring compact volumes of 50 to 125 pages, the series covers a range of content from professional to academic.

Typical publications can be:

- A timely report of state-of-the art methods
- An introduction to or a manual for the application of mathematical or computer techniques
- A bridge between new research results, as published in journal articles
- A snapshot of a hot or emerging topic
- An in-depth case study
- A presentation of core concepts that students must understand in order to make independent contributions

SpringerBriefs are characterized by fast, global electronic dissemination, standard publishing contracts, standardized manuscript preparation and formatting guidelines, and expedited production schedules.

On the one hand, **SpringerBriefs in Applied Sciences and Technology** are devoted to the publication of fundamentals and applications within the different classical engineering disciplines as well as in interdisciplinary fields that recently emerged between these areas. On the other hand, as the boundary separating fundamental research and applied technology is more and more dissolving, this series is particularly open to trans-disciplinary topics between fundamental science and engineering.

Indexed by EI-Compendex, SCOPUS and Springerlink.

Tin-Chih Toly Chen

Explainable Ambient Intelligence (XAmI)

Explainable Artificial Intelligence Applications in Smart Life

Springer

Tin-Chih Toly Chen
Industrial Engineering and Management
National Yang Ming Chiao Tung University
Hsinchu, Taiwan

ISSN 2191-530X ISSN 2191-5318 (electronic)
SpringerBriefs in Applied Sciences and Technology
ISBN 978-3-031-54934-2 ISBN 978-3-031-54935-9 (eBook)
https://doi.org/10.1007/978-3-031-54935-9

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Paper in this product is recyclable.

Contents

Chapter 1
Ambient Intelligence (AmI)

Abstract This chapter begins by defining ambient intelligence (AmI). The chronology of the emergence of the most widely used AmI technologies is then provided. Through reviewing some cases in the literature, AmI applications prevalent in various fields are mentioned, such as emotionally pleasing design, telemedicine and telecare, context-aware recommendation, home care and assisted living, smart home, smart tourism, and smart factory. The issues and challenges that need to be addressed by existing AmI applications are then discussed. To solve these problems and challenges, the most popular artificial intelligence (AI) technologies are highlighted. However, some AI technologies are very complex, limiting the interpretability and credibility of related AmI applications. To address this problem, the combination of AmI and XAI results in XAmI, and a review of some existing XAmI applications is performed. Based on the review findings, the application of XAmI techniques and tools is expected to mitigate the social impacts of AI applications in AmI on fairness and bias, security, verifiability, and accountability.

Keywords Ambient intelligence · Artificial intelligence · Explainable artificial intelligence · Explainable ambient intelligence

1.1 Ambient Intelligence (AmI)

Ambient Intelligence (AmI) is the vision of an environment supporting users in an unobtrusive/transparent, interconnected, adaptive, dynamic, embedded, and intelligent way [1–2]. In this vision, environments are sensitive to the needs of their inhabitants and able to anticipate their needs and behaviors [3–4]. AmI systems come in many forms, such as smart homes, smart factories, smart stores, mobility guides, virtual tours, ubiquitous healthcare systems, online social networks, telemedicine, and telecare. The key to the success of an AmI system is the perception and interpretation of user needs [5]. To achieve this, human factors and ergonomics (HFE) is a useful tool [6].

T.-C. T. Chen, *Explainable Ambient Intelligence (XAmI)*,
SpringerBriefs in Applied Sciences and Technology,
https://doi.org/10.1007/978-3-031-54935-9_1

The concept of AmI was proposed in 2001. Over the years, many AmI applications have become more common and less expensive (see Fig. 1.1). Today, smart switches that can be controlled via a remote smartphone cost less than $100. However, after years of attempts, some AmI applications have proven unsuccessful, such as smart clothing, which is one of the key technologies for telemedicine [7–8]. Until recently, technological, cultural, and market conditions did not support the widespread adoption of smart clothing [9–10]. In contrast, taking smart homes as an example, the global smart home market was estimated to be US$80.21 billion in 2022 and is expected to grow from US$93.98 billion in 2023 to US$338.28 billion in 2030 [11].

The COVID-19 pandemic has brought about dramatic changes in the applications of AmI technologies. AmI technologies applied during the COVID-19 pandemic differed from those applied before the outbreak (see Fig. 1.2). According to Chen and Wang's observations [12], users' motivations for applying AmI technologies have also changed. Before the outbreak of COVID-19, AmI technology applications were called for better **smart life**. In contrast, applications during the pandemic were mainly about avoiding infection (i.e., preventing disease), that is, focusing on **distant healthcare**.

In **location-aware services (LASs)**, applications were designed to help find where to buy masks, remind users to wear masks, or detect whether users were wearing masks. In **telecare**, most applications developed during this period were used to provide information or news about COVID-19, record symptoms, and contact tracing. In **smart home**, smart watches were used to track people's health (including heart rate and sleep time) and physical activity (including gestures, movements, steps, and movements), since people stayed at home longer. In **smart tourism**, hotel visitors felt more at ease if robots provided services during the pandemic. Additionally,

Fig. 1.1 Emergence of AmI applications

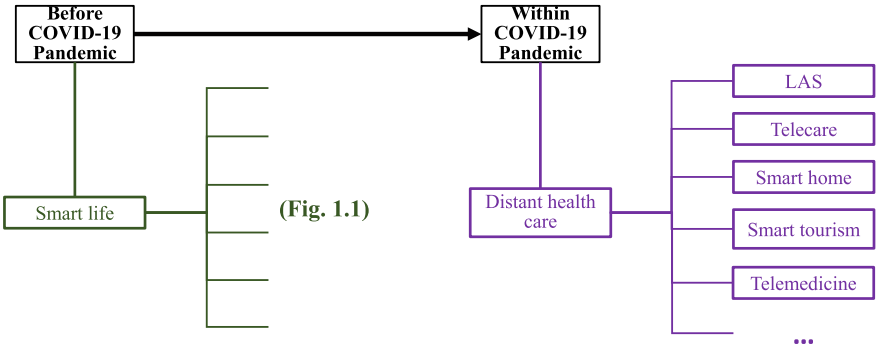


Fig. 1.2 Comparison of AmI technologies applied before and during the COVID-19 pandemic

in **telemedicine**, the GPS tracker on a smart bracelet or sociometric badge helped measure a patient's temperature and blood oxygen levels, ensuring the patient's commitment to isolation and social distancing.

1.2 Architecture and Operational Procedure of AmI Systems

Cook et al. [13] established an AmI system architecture containing four layers. Figure 1.3 shows how various disciplines map to the four layers [14].

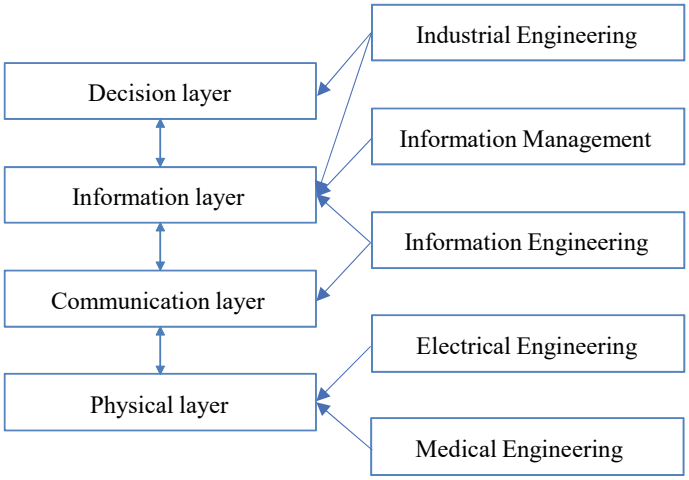


Fig. 1.3 Mapping various disciplines to the four layers of an AmI system

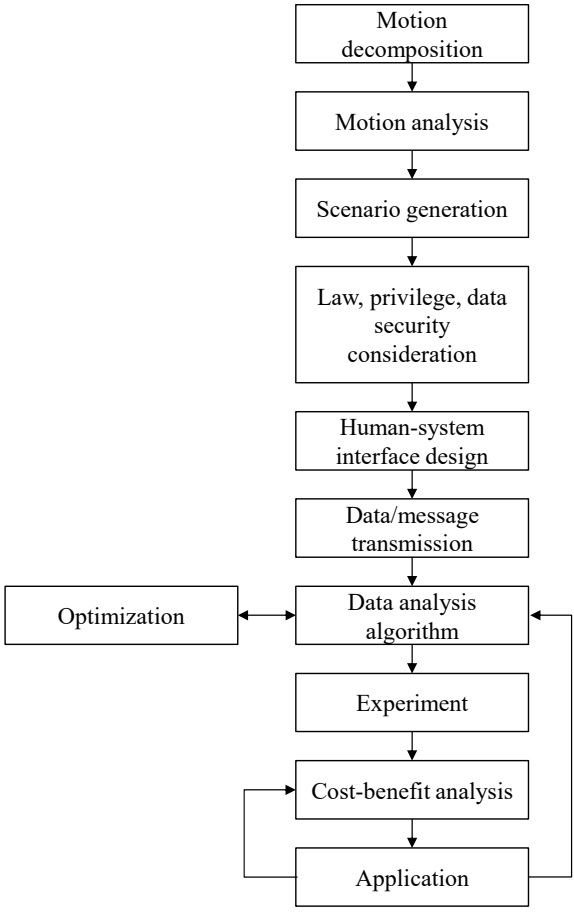


Fig. 1.4 Systematic procedure for constructing AmI systems or providing related services

Chen [15] established a systematic procedure for constructing AmI systems or providing related services (see Fig. 1.4).

1.3 Examples of AmI Applications

In **affective and pleasurable design**, easy-to-understand algorithms need to be identified so that designers can use to create novel concept designs. Wang and Yang [16] selected popular motorcycles as sample products and used the most distinctive front handle covers as design targets. Their affective and pleasurable design approach consisted of three stages: preparation, construction of conceptual creativity, and semantic analysis. After comparing random sketches of ideas with existing designs on the market, they found that some of the conceptual designs obtained using the