Chapter 3
Transfer Learning for IoT Applications:
Explainable AI for Adaptive Systems Integration

R. N. Ravikumar
https://orcid.org/0009-0009-3705-1681
Marwadi University, Rajkot, India

N. Sivakumar
https://orcid.org/0000-0001-5039-072X
Marwadi University, Rajkot, India

S. Aarthi
https://orcid.org/0009-0006-9064-2091
Marwadi University, Rajkot, India

S. Kavitha Bharathi
https://orcid.org/0000-0002-5630-7963
Kongu Engineering College, Erode, India

Anand Singh
Marwadi University, Rajkot, India

S. Sujitha
Kongu Engineering College, Erode, India

ABSTRACT

The integration of IoT and AI enhances autonomous and adaptive systems, leveraging Transfer Learning and Explainable AI (XAI) for improved efficiency. This research explores AI-driven IoT applications, bridging theory and practice. Transfer Learning minimizes data needs and computational costs, increasing flexibility across smart cities, precision agriculture, healthcare, and energy management. AI models act as knowledge transfer nodes, enabling adaptive decision-making. XAI ensures transparency, interpretability, and trust in AI-assisted IoT, crucial for ethical compliance and reliable decision-making. Challenges include data processing, scalability, security, and privacy. The study addresses bias detection, fair data practices, and

DOI: 10.4018/979-8-3373-3146-1.ch003

ethical AI deployment. Using interdisciplinary research and practical examples, it guides researchers, engineers, and industry professionals in advancing intelligent IoT systems.

1. INTRODUCTION

The high growth of Internet of things IoT generates a requirement of intelligent systems to be adaptive so that they can operate under varying conditions. Machine learning transfer learning utilizes past models to optimize the efficiency of new tasks that improves the performance of IoT applications. Transfer learning implemented in the IoT devices allows them to run on the ready models rather than manually training them thereby providing better performance and reducing costs and speeding up development timelines. XAI acts as a critical framework to maintain transparency since AI-oriented complex systems need sound adapted decision processes, in the working systems. Explainable AI (XAI) integrated into adaptive IoT systems provides users insight into AI model decision processes which helps users trust healthcare applications and applications for smart cities and industrial automation. Systems adapted through learning need accurate interpretability establishment to achieve essential operational integrity. System developers can produce transparent AI models with flexible capabilities through the combination of XAI techniques SHAP, LIME and Grad-CAM with transfer learning approaches. The cooperative power enables better system performance and eliminates regulatory and ethical challenges which together create secure user-centric AI-powered IoT products. (Kumar Dinkar et al., 2024)

1.1 Overview of Transfer Learning in IOT

The Internet of Things (IoT) creates an extensive interconnected device system that tracks data between devices to achieve smart control across domains of residential living and health care and industrial control systems. The process of creating machine learning models from primary sources for complete IoT applications remains unacceptable because most devices lack sufficient processing power and require substantial datasets. Transfer learning resolves the challenge through the effective utilization of pre-trained model knowledge which gets adapted for new yet similar tasks. The approach offers two significant advantages that reduce the duration of training and increase efficiency and enable IoT devices to generate intelligent evaluations using minimal data platforms. Transfer learning enables IoT systems to adapt to new environments with the previously trained models without having to retrain the entire model. In a process that does not require large amounts of new