Chapter 12
Prospects of Deep Learning and Edge Intelligence in Agriculture: A Review

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ABSTRACT

Agriculture is one of the high labor occupations around the globe. To meet the population growth and its demand, with the increase in labor cost, there is a need to explore efficient autonomous systems which may replace the traditional methods. Computer vision, edge, and deep learning (DL) models have become a promising area of research. This new paradigm of deep edge intelligence is most appropriate for agriculture activities where real-time decision-making is very important. In this chapter, the authors conduct a systematic literature review on deep learning-aided edge intelligence (EI) applications in agriculture to gather the evidence for prospects of DL at edge in agriculture. They discuss how DL models have shown outstanding performance within limited time and computation resources, and also provide future research directions to enhance the viability and applicability of complex deep learning (DL) models deployed at edge devices in agricultural applications.

1. INTRODUCTION

Agriculture is the foundation of society and national economies, and one of the most important industries for every country. The United Nations Food and Agriculture Organization (FAO) defines food security to be existent when all people will always have economic and physical access to food that is secure, adequate, and has nutritional value for a healthy life. However, with the consistent growth in population,

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recent studies indicate a need to increase food production by 70-90% by 2050 to cater to 9 billion people (Gulzar et al., 2020). Agriculture problems have been always one of the critical challenges for humans. Owing to a continuous decline in global cultivable land, increasing the productivity of the existing agricultural land is highly necessary (Chandra et al., 2020). Agriculture problems have been always one of the critical challenges for humans. Technology advancement has been seen in agriculture to change the conventional methods of farming through modern technologies.

Smart farming has become very popular and is important for tackling various challenges of agricultural production such as productivity, environmental impact, food security, and sustainability (Kamilaris & Prenafeta-Boldú, 2018). The rise in food demand poses several challenges to agriculture and this need has led to the scientific community focusing their efforts on developing efficient and sustainable ways to increase crop yield. Due to the disruption in the cycles of rainfall, increasing atmospheric temperatures and a rise in CO2 emissions has brought food security to be at risk globally. This has posed severe threats to food availability, quality, quantity, and livelihoods of the stakeholders in the agricultural industry (Gulzar et al., 2020).

We have seen technology has played a vital role in agricultural advancement. Acquiring timely and reliable agriculture information such as crop growth and yields is crucial to the establishment of related policies and plans for food security, poverty reduction, and sustainable development. In recent years precision agriculture (PA) has developed rapidly, which refers to a management strategy that gathers, processes, and analyzes temporal, spatial, and individual data in agricultural production (Liu et al., 2021). The era of smart agriculture 4.0 emphasizes unmanned operations by use of the latest technology. The application of technology in agriculture aims to provide farmers with the appropriate tools to support them in their decision making and automation activities by offering products, knowledge, and services for better productivity, quality, and profit. (Friha et al., 2021).

Theories and technologies of Artificial Intelligence (AI) have made great progress when it comes to AI and computer vision (Wang et al., 2020). AI applications are based on machine learning (ML) which have long been applied in a variety of applications to discover patterns and correlations due to their capability to address linear and non-linear issues from large numbers of inputs (Liu et al., 2021). In recent years, due to the tremendous progress and popularity of image acquisition equipment, the image has become a huge amount of data and easy to obtain, which makes image analysis very challenging with traditional ML methods (Zhang et al., 2020).

Deep Learning belongs to machine learning (Zhang et al., 2020), is the most dazzling sector, and has made substantial breakthroughs in a wide spectrum of fields, ranging from computer vision, natural language processing, and big data analysis (Zhou et al., 2019), based on representation learning of data, which realizes artificial intelligence by means of artificial neural networks with many hidden layers and massive training data. Recently, DL based algorithms have achieved much higher recognition in accuracy than traditional algorithms based on shallow learning, and compared to other machine learning techniques, DL has shown powerful information extraction and processing capabilities (C.-J. Chen et al., 2021). DL methods have consistently outperformed traditional methods for object recognition and detection in the Computer Vision Competition since 2012 (Chen & Ran, 2019). In agriculture also DL has been successfully applied in applications such as weed detection, crop picking, pest control, and disease detect. The expressive power and robustness of deep learning systems can be effectively leveraged researchers to identify complex patterns from raw data and devise efficient precision agriculture methodologies (Chandra et al., 2020).