Chapter 4
Deep Learning and Computer Vision in Smart Agriculture

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ABSTRACT

The exponential growth in the world population has led to an ever-increasing demand for food supplies. This has led to the realization that conventional and traditional methods alone might not be able to keep up with this demand. Smart agriculture is being regarded as one of the few realistic ways that, together with the traditional methods, can be used to close the gap between the demand and supply. Smart agriculture integrates the use of different technologies to better monitor, operate, and analyze different activities involved in different phases of the agricultural life cycle. Smart agriculture happens to be one of the many disciplines where deep learning and computer vision are being realized to be of major impact. This chapter gives a detailed explanation of different deep learning methods and tries to provide a basic understanding as to how these techniques are impacting different applications in smart agriculture.

INTRODUCTION

With the rapid increase in global population, challenges related to food supplies are becoming a huge concern. UN reports [26], project upwards of 9.7 billion people on the planet by the year 2050 and according to The UN Food and Agriculture Organization, feeding this expected population would require augmenting the current food production by approximately 70% (Jin, Fu & Zhang, 2014). Also, it is
important to keep in mind that millions of people around the world are dependent on agriculture for their livelihood and suffer from different issues impacting the yield of their crop which are not limited to soil incompatible plantation of crops, fertilizer overuse, weeds, improper management of yield and plant diseases. Traditional methods are also known to cause degradation to the environment which in turn acts as a contributing factor to the reduction of productivity in the future. Employment of labor in tedious tasks ought to be automated in order to better manage costs incurred during the maintenance of the crop. This rise in demand coupled with the inability of conventional methods to meet the current demands and necessities of food supply, are a clear indication that better and more efficient methods need to be devised in order to match the expected needs of the future, else a global food crisis will be inevitable. These methods are being understood to be a combination of productive traditional practices and the innovations of agronomists and agricultural engineers, leading to the growth of a field known as Smart Agriculture. Smart agriculture enables better monitoring, analysis and understanding of the complex agricultural ecosystem, bringing together different technology-based approaches to the diverse field of agriculture. It would be an understatement to say that smart agriculture is the key to a secure and sustainable future, and it is the sub-fields of Agricultural Disease Management and Crop Prediction which are expected to make the greatest impact.

The first and most important aspect that technology in relation to smart agriculture covers, is the dissemination of the right information to the farmers at the right time. When crops are grown in remote, distant farmlands, the services of an expert may be hard to get. In such cases, using a remote application which can provide the necessary information can prove extremely beneficial. Providing accurate weather condition data and weather forecasts shall minimize crop loss resulting from harsh weather conditions. Using images of leaves, an accurate diagnosis of probable plant disease can save the entire crop from an infestation and even recommend the right type and amount of pesticide. Using an entire spatial image of a field taken from a drone or an Unmanned Aerial Vehicle (UAV), the growth of weeds can be detected and controlled amounts of herbicides can be used, minimizing the environmental harm caused by uncontrolled pesticide use, allowing for efficient management of agricultural diseases. The spatial images taken by the drone can also be used to predict healthy yield from the crop, as well. Throughout the supply chain, food is wasted due to problems in harvesting, storage, packaging and transportation. A fruit counting and yield production algorithm for commercial purposes can help growers plan the manual labor requirement for all the tasks and make necessary packing and storage arrangements before their sale, thereby highlighting the importance of accurate yield prediction.

Two different but linked domains contributing heavily to groundbreaking innovations in the field of smart agriculture-based work in management of agricultural diseases and yield prediction are that of Deep Learning and Computer Vision. Deep Learning is a part of a family of different machine learning algorithms which involves the training of multiple layers of perceptrons, modelled based on the functioning of the network of neurons in the human brain; sometimes also referred to as a neural network. These artificial networks can be fed text, images, videos or audio as input and they learn complex relationships between the said input data. The learned relationships are later used to perform different kinds of tasks in the required series of domain specific operations and applications. Deep Learning finds use in the fields of image and pattern recognition tasks, face recognition on social media applications, speech recognition tasks like the voice control built into smartphones, speakers and other electronic devices and even sentiment analysis tasks that involve understanding the class of opinion behind written text. Computer vision on the other hand is a specific field which aims to provide machines with a similar if not better sense of vision as compared to humans, i.e. being able to infer and extrapolate different forms
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