6CS014

Complex Systems

Task 2: Academic Report

Computer farmers:

A study of the application of AI within horticulture

Introduction

The United Nations World Population Prospectus (2019) shows that, at present, the global population is currently approx. 7.7 billion, this figure is expanding and not contracting. The growth predictions show that by 2050 the global population could hit 10 billion. As the number of human beings has and will continue to increase so too will the demand for basic necessities such as food and water. Whilst there is no panacea that can solve the potential food shortages that will face nations in the coming decades, one possible salve is to be found in the application of AI to the complex industry of horticulture. This paper looks at existing solutions that are commercially available now as well as what may be possible in the future. The areas explored include research into the general applications of AI with some focus upon management of crops, covering watering, soil monitoring and disease identification, as well as harvesting and crop collection.

Aim and Objectives

The aim of this paper is to examine the impact of AI within the field of horticulture. Furthermore, to research and review past, present and future applications of AI to this very complex system. This aim will be achieved by meeting singular key objective of,

analysing various published works. Following the literary research, findings will be noted with relation to each source. Ultimately a conclusion will be drawn expanding upon the findings.

Literature Review

It is very clear that AI within the sector of Horticulture is attracting large sums of investment. Drotleff (2019) comments that in 2017 Novel Farming systems was able to raise $198 million, this represented a huge increase of 560% on the previous year. Umali (2019) echoes this, reporting that the Government of New Zealand as allocated $8.4 million towards the application of AI via a number of local horticulture businesses.

There is a great range of areas that AI is able to assist with, within the farming community. Stoltzfus (2019) in his article, discusses a number of advances and their impact upon agriculture. It is possible to arrange these new technological breakthroughs into two separate and distinct groups. Firstly, how AI approaches the growth and management of the crops. Secondly, how AI is changing the way crops are picked and harvested. Harvest Croo (2019) have developed an automated strawberry collector, they report, that it is capable of picking a single strawberry plant within 8 seconds as well as having a travel time of just 1.5 seconds between plants. The nett effect being that a single robotic strawberry picking machine is capable of achieving the same productivity as that of 30 individual human workers.

Returning to the first category of AI application, that which focusses on the actual growth of the plants. A large amount of both resources and work have been placed into the ‘Big Data’ of farming, this covers the accumulation of vast amounts of data in real time for analysis purposes it is worth noting that typically this analysis will also utilise existing historic data alongside its real-time equivalent. Kassner (2019) comments that farmers are not typical adopters of new technology, however, given some of the solutions put forward it is becoming easier to convert the less tech savvy agronomists. He goes on to discuss the application of large numbers of independent sensor arrays that measure variables such as soil conductivity, ground moisture and atmospheric conditions. Once this data is harvested, it is sent via satellite or cellular transmitters to the data centre, where AI can get to work on information using complex algorithms, before finally returning the data in a simple readable format such as an app or other web-based

format. In this example the farmer uses this information to decide when to water his crops and by how much. Again, it can be argued that this application clearly demonstrates a reduction in waste, be that wasted time in the possible scenario of watering crops when it is not needed or alternatively wasted resources in the water itself.

A significant level of research has also been carried out in the more focused area of tackling plant disease. It is worth noting that this is not exclusively new science or even new research as a lot of the ideas from the Bauer, M. E. LARS technical report titled “Remote Sensing as a Means of Detecting Crop Disease” (1971) still hold true today. However, it is of note that the report draws the conclusion that at that time remote sensing of disease over a large geographical area was “unlikely at this time”. Interestingly Huang W et al (2012) returns to this very idea and is able to achieve much better results. This is down to the technological advances within this field.

As Donaldson et al (2019), comments, having the new technology in place to spot crop infections at an earlier stage, certainly earlier than existing methods of human observation, there comes the inherent need to have an equally efficient treatment solution. Moreover, this creates the need for new solutions to be researched and developed. Parke and Grunwald (2012) in their older paper echo this sentiment, being able to catch pests and pathogens earlier is only effective when you also have the ability to treat and neutralize those threats to the crop.

Analysis of Findings

The research has found that there is a high level of global investment directed to the application of AI within the field of horticulture. This investment was shown to be originating from both the private and public sectors. It is also worth noting that the application of funding is not a recent development. Indeed, there is much evidence that whether for increases in efficiency or simply expanding scientific knowledge, there has always been a benefactor to be found.

It was found that the application of AI could be broadly categorized into two distinct areas. The first being concerned with the growth and management side of the crop. While the second looked at the harvesting of the crop. It can be observed that there is a certain amount of crossover between the two.

When looking into the growth and management of crops, most applications involved some sort of sensor, that worked either autonomously or semi autonomously to take and record a specific measurement, be that soil PH level or ground moisture level. It is worth noting that this is not a new concept, rather the automation of a task that had already been proven to yield positive results. The main difference being that now the data is recorded, stored and sent electronically from the sensor to the individual responsible. This allows for decisions to be made sooner based upon the recorded information.

Looking at the other grouping, the application of AI to crop harvest, it must be noted that concept of assistance with collection of crops has always been some form of incubator for new inventions. There have been many mechanical machines that have allowed for a faster approach to the problem, though typically this will be as an aid for the existing human worker. Now with the application of AI, the research has shown that it is the human worker who is removed from the equation, in fact most sales literature for any automated crop harvesting machine, explicitly details how many humans it replaces. Where the application of AI tends to take place is in machine vision, the detection of the fruit for example, then an assessment of its ripeness, before then making its decision on whether to pick it or leave it. It is this series of decisions based on sensory data that shows the value of AI.

Another finding that was apparent during the literary review was that current research and, by extension, application of AI in the many and varied fields of horticulture is found to be based upon research carried out some decades ago.

Conclusion

With the original aim in focus, does AI within horticulture help deal with tackling the issues created by population increase. It could be concluded that yes it does help, though there is an argument to be made that this is an indirect consequence produced as a direct result of the efficiency increases.

Through the application of AI growers, are now able to have a level of awareness that was previously, improbable at best and impossible at worst. The level of access to this invaluable data in such a timely fashion allows for much better management of precious resources. It is worth noting though that as these advances have occurred so swiftly,

within no more than two generations (60 years), this has caused some issues with adoption of the newer technologies. If a parallel could be drawn between this and say the adoption of the mobile phone, then it could be concluded that as we move further into the future these new tools will be accepted and used with less friction.

The simple fact that growers are able to now, thanks to AI, detect crop disease earlier than would be possible with the human eye, is another example of a secondary efficiency saving. By being able to detect earlier they are then able to treat earlier, ultimately reducing potential waste.

Looking forward, it is not unreasonable to believe that the level of automation will increase, offering further savings and related benefits. If you imagine that a farmer has responsibility for a single apple tree, just the one, then you would be safe to assume that, that tree would flourish, receiving 100% of the farmers attention. Now that same farmer has an orchard of 3000 apple trees, the level of time and attention would now be divided and possibly as a result the harvest may be reduced, things could go missed. One solution is to employ more workers; however, this is not practical for a great many reasons. The application of AI means that the very same farmer could solve these issues for a reduced financial cost. A fleet of monitoring drones would work tirelessly to maintain his orchard. It is not inconceivable, that in the future the same drones would then signal other automatic machines who would then treat disease or harvest the apples.

Could this mean in the future that farming becomes almost entirely automated, very possibly.

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