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APPLICATION OF HYDROPONIC FARMING USING LEAFY GREEN MACHINES FOR SUSTAINABLE ORIENTED AGRICULTURE BY APPLYING DEEP LEARNING METHODS

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Abstract

Leafy green machines are employed in this paper using deep learning techniques for addressing challenges of food production. By examining the production and agricultural problems under study, the technology of leafy green machines can be implemented for overall performance. Hydroponic system, multi-planned air flow, moisture, number of nutrient thresholds of carbon dioxide and nitrogen can be controlled and operated using deep learning techniques. IoT sensors and use of UAVs assist in controlling the other aspects of production. The study evaluates the application of deep learning methods that provide high-quality yields of production using organic manure as nutrients.

Key words: Deep learning, agriculture, leafy green machines, virtual farming, hydroponic farming, controlled environmental agriculture.

Introduction

Population is increasing exponentially and its evident that the current food production may not reach the expectations by 2050. Environmental issues, global warming, raising towers, water shortage, land shortage, and lack of farmers are certain reasons for decrease in crop yield. Automation of the process and mechanizing with the help of technology will rapidly increase the crop production and meet the demand requirements. Deep Learning techniques are applied to solve and automate the procedure on these prevailing issues. Data analysts and scientists are continuing the research in agriculture sector to address the issues. Forecasting, weather estimation, crop outcome, monitoring water levels, detecting crop diseases, type of soil and removal of weeds are some of the major areas of research through deep learning methods (Lakshmi and Naresh, 2018), (Aditya and Kulkarni, 2016).

Artificial Intelligence, Machine Learning and Deep Learning are novel advanced computational methods (Yao and Zhang, 2017). These techniques can be collaborated with agriculture sector for a unique research to improve the speed, type, new variety and protection should be employed. Super computational power of deep learning techniques analyses the stream line methodology to understand the compatibility of molecules by using Atom Net framework (Allen, 1998) (Andriyas and McKee, 2013). This technique even identifies controlling mechanism of insects and pests by predicting the peculiar patterns of molecules which are given for crops while breeding.

Discovering innovative practices for high yields, diversified plant breeding and crop protection sophisticated artificial intelligence and machine learning methods are applied.

With the development of technology small farmers problems (Greenwood, 2016) can be waived by implementing these unique approaches for agriculture (Adrian and Carlos, 2017) (Anuj and Abhilasha, 2015).

Environmental changes, ecological disorders, soil quality and temperature variants can also be taken care by using the modern techniques (Bowring, 2015), (Karandeep, 2016). These imbalances should be overcome for better harvests, protect their crops and deliver more to society in the face of mounting environmental challenges (Cressman, 2016), (Konstantinos and Konstantinos, 2015). Some solutions

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are given by leafy green machines by applying the hydroponic farming techniques with artificial climatic conditions using artificial intelligence and machine learning (Siddique, 2015), (Gerand, 2015). The main aim of this production is to support sustainable environment friendly production of crops. Leafy green machines produce crops such as green beans, variety lettuce, basil, mustard, mint and other tiny leafy veggies. Such a variety of taste, color and texture can also be decided for all veggies under production using organic nutrients usage.

This paper is organized as follows. Section II gives case study on existing technique. Practice of leafy green machines is detailed in Section III. The approach improving the existing farming technique is proposed in Section IV. Implementation of the proposed method is described in Section V and potential results and evaluation are given in Section VI. Finally, conclusions are drawn in Section VII.

Background Study

The case study considered in this paper is on leafy green machines which produce crops using hydroponic farming. This type of cultivation started in an urban campus where students are trained to grow veggies in the containers which are monitored using computers (Ruchit, 2016). Student farmers are trained in consistent monitoring of crops and maintain certain environmental requirements such as climate, irrigation and ultraviolet sunrays (Siddique, 2015).

Crops like green beans, spinach, peppers, tomatoes, lettuces and herbs are a small group which is produced using leafy green machines. Drip irrigation by re-circulating mixture of ingredients such as nutrients and water are given for the roots rather than for the soil. Some insights drawn from various farm hacker's community are discussed as below:

• Plant physiology to computer science can diminish the complexities and controversies of sustainability by Catherine Arnold (Brad and Jon, 2013).

Fig. 1: Neon Red lights for hydroponic farms in containers (Brad and Jon, 2013).

• Graeme Marcoux (Lakshmi and Naresh, 2018) applied remote sensing mechanism to operate the crop growth in the freight farms for the crop irrigation.

• Marcoux's vertical farms use conventional farming techniques indoors with no pesticides and fertilizers (Lakshmi and Naresh, 2018).

• Will Borden observed that indoor farms are energy hoggers ss this requires energy costs, transport, refrigeration, farm tools and water supplies. He also pointed that the energy generated by LED will shrink the carbon footprint in vertical farms (Lakshmi and Hemanth, 2019).

• Crowdsourcing crops for potential network farmers using climate recipe and food systems are suggested by Caleb Harper (Brad and Jon, 2013).

• Edible plants in vertical columns with neon red energy generators and ceiling spigots for cascading water is one of the growing techniques by Shawn Cooney (Lakshmi and Hemanth, 2019).

Materials and Methods

Methodology of Leafy Green Machines

Increasing food needs mitigating environmental effects of conventional farming raises the farmer entrepreneurs. Innovative farming practices growing fresh food in massive quantities is a challenge which is addressed by deep learning methodologies using leafy green machines. Sustainable farming is implemented to reduce environmental impacts of monocropping and eradicating dependable pesticides (Quan Le, 2015). Controlled environmental agriculture has a greater impact on ecological footprint and market research for ability scaling in crop production (Allen W., 2015).

• Spectrum of red and blue neon lights is used efficiently on crops for photosynthesis process.

• Mixture of nutrients and water solution is supplied in closed loops using hydroponic delivery system.

Fig. 2: Lettuce plants using hydroponics (Brad and Jon, 2013).

Table 1: Metrics of Components user for Farming.

Plant type	Water usage	Nutrient absorption	Growth level	Sunlight absorption
Lettuce	100 ml/day	6 gm/day	25 cm	7 Watt
Serrol	85 ml/day	5 gm/day	30 cm	6 Watt
Fenugreek	78 ml/day	4 gm/day	15 cm	4 Watt
Coriander	88 ml/day	5 gm/day	20 cm	5 Watt

• Sensors are installed for monitoring the airflow, temperate and humid percentages in the environment.

• UAVs are installed for controlling the pests and blights by regular examination.

• Moist climate needs to be maintained for winter temperature in order to enhance quality of the crop.

Controlled Environment

Artificial illumination using neon lights in fig. 1, sensor-based temperature monitoring system and controlled flow of nutrient solution enable to develop such smart farming machines. These machines ideally maximize the crop yield by adapting organic methods.

Vertical Hydroponic LED Farming

Vertical farming using hydroponics optimizes the use of water by recirculation. This system uses sustainable practices such as avoiding pesticides, fertilizers and chemical applications. Water sprinklers and air showers are used for maintaining the temperature and moisture in the environment.

Lettuces & Leafy Greens Year-Round

Mints, lettuce in fig. 2, spinach, mustards, tomatoes, basil, fenugreek, and kale are popular leafy greens that can be cultivated using hydroponic machines. Adapting such methods enable us to harvest leafy-greens year-round at our roof-tops.

Linear Growing Feet

Hydroponic farming is cultivated by vertical arrangement of growing media without soil. Root-tops, lawns or rafts are viable for irrigating leafy greens. So, linear growing feet are popular for cumulative crop production.

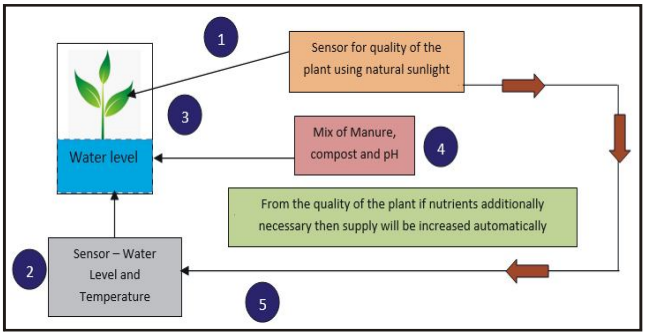

Fig. 3: The process flow of organic hydroponic farming.

Table 2: Prediction from Neural Network after 6 Days of Study.

Days	Plant	Sunlight	Water	Manure and pH
01	Lettuce	7 Watt	115 ml	6 gm
	Serrol	5 Watt	89 ml	5 gm
	Fenugreek	3 Watt	80 ml	4 gm
	Coriander	4 Watt	95 ml	4 gm
02	Lettuce	8 Watt	119 ml	6 gm
	Serrol	6 Watt	84 ml	5 gm
	Fenugreek	4 Watt	77 ml	5 gm
	Coriander	3 Watt	92 ml5	5 gm
03	Lettuce	8 Watt	117	7 gm
	Serrol	5 Watt	91 ml	5 gm
	Fenugreek	3 Watt	77 ml	4 gm
	Coriander	4 Watt	86 ml	4 gm
04	Lettuce	9 Watt	107	6 gm
	Serrol	6 Watt	84 ml	4 gm
	Fenugreek	4 Watt	75 ml	5 gm
	Coriander	3 Watt	92 ml	4 gm
05	Lettuce	7 Watt	105 ml	5 gm
	Serrol	7 Watt	88 ml	5 gm
	Fenugreek	4 Watt	76 ml	6 gm
	Coriander	5 Watt	89 ml	4 gm
06	Lettuce	7 Watt	114 ml	7 gm
	Serrol	6 Watt	87 ml	5 gm
	Fenugreek	4 Watt	74 ml	4 gm
	Coriander	4 Watt	90 ml	4 gm
Prediction value for Day 07	Lettuce	7.555555 Watt	105 ml	7.2 gm
	Serrol	5.800090 Watt	90 ml	4.5 gm
	Fenugreek	4.667922 Watt	75 ml	5.8 gm
	Coriander	5.000032 Watt	86 ml	4.5 gm

Proposed Methodology

In order to obtain the higher yields and quality crop using technologies the following is the step-wise process in fig. 3:

Step 1. Use of artificial neon light is replaced using natural sunlight.

Step 2. Implementing uninterrupted monitoring system using sensors for automatic capture of data.

Step 3. Less usage of soil results in avoiding fertilizers and pesticides.

Step 4. Nutrients are supplied in water using mix of manure, compost and pH components.

Step 5. Quality metrics of plant's computations are observed using the sensor units.

Step 6. Amount of water required, nutrients, components of manure are measured using deep learning algorithms. From the previous inputs given, it measures the necessary changes for plant growth using neural networks techniques.

Table 3: Organic Manure Vs Chemical Fertilizer.

Plant type	Organic Manure	Chemical Fertilizer
Lettuce	22 cm	28 cm
Serrol	45 cm	40 cm
Fenugreek	20 cm	15 cm
Coriander	22 cm	25 cm

Implementation

In this study we used lettuce, Serrol, fenugreek and coriander plants. Usage of water, absorption of nutrients, growing environment and temperature used are observed for each plant type. We used two-way process to evaluate the crop quality and organic content. In order to observe this, we used artificial nutrients for some plants and organic compost to some of these plants. Equal amount of sunlight, water and temperature are maintained for both the collections.

Results and Discussion

From table 1 it is observed that fenugreek plants use less water, nutrients and sunlight compared with other plants. Growth is fast in Serrol plants; lettuce plants require more water for proper growth. table 2 gives details of 1-week data collected from various sensors such as water, pH and sunlight. 20 weeks data have been collected on these four plants from the period January 2019 to July 2019. One-week data are represented in table 2. 6 days data set is given as input and 7^{th} day was the computed prediction values.

Table 3 gives the height metrics of the crop; this measures the quality of the crop. Crop quality is observed in table 3 comparing organic manure with that of chemical fertilizers.

Conclusion

Agriculture sector has a vital role for the global development. Indian farmers have to update their farming mechanisms for increasing the crop yield with less amount of time. Deep learning methods are naïve approaches for increasing the crop production as shown in this paper. This paper reveals the 50% increase in the crop yield in lettuce, Serrol, fenugreek and coriander plants by adopting the proposed model.

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