Developing an Intelligent Agricultural System Based on Long Short-Term Memory

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Abstract. There were many undeveloped countries upgraded to emerging countries in recent years; as a result, the farmland has been transferred to commercial or industrial lands that significantly reduce the areas of farmland, lowers down the agricultural labor force due to the population aging and further decreases agricultural output. Additionally, many of the farmland are outdoor farms, which are limited by water resources and electricity. The study develops an intelligent agricultural system based on Long Short-Term Memory (LSTM), through utilizing solar power to monitor crop environments. The key features presented in this study are 1. reducing the electrical wiring cost by using solar power; 2. adding weather forecast information to initiate the equipment and avoid the waste of electricity; 3. using the environmental monitor to check whether the crop is at a suitable environment and the system will alarm if the environment is not suitable. Through LSTM to monitor environments and lower the initiating power for avoiding electricity waste. From the experiments of the research, the method is proved to be feasible and is usable without the need for additional power-supply equipment.

Keywords: Intelligent agricultural · Long Short-Term Memory · Artificial intelligence

1 Introduction

Today, the world population has constantly increased that leads to the high demands of food, according to the literature [1], from 2019 to 2030, the world population will be nearly doubled, which means that the demand of food will be doubled as well. However, many undeveloped countries are transferring to emerging countries, which reduces the areas of farmland and agricultural output; it is believed to cause food crises in the future. The literature [2] has pointed out the need for intelligent agricultural systems to enhance agricultural output and monitor farm environments to avoid the outbreak of

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food crises and cope with the losses caused by climate change. Intelligent agriculture could decrease the issue of agricultural labor force and monitor farm environments continuously. The literature [3] mainly discusses the shortages of electricity and water resources today. Outdoor farms usually lack water resources, which will cost more on constructing electrical wires; therefore, intelligent agriculture could control irrigation and sprinkler systems to boost the usage of water resources. Literature [4] also mentions that with the increase of climate change and environmental awareness, the shortages of electricity and water resources will be more severe in the future and it will accelerate the problem of food crises. Hence, relying on intelligent agriculture will enable farmers to utilize electricity and water resources effectively and grow agricultural output.

In the literature [5], it suggests the construction details of intelligent agriculture, the system could recognize the conditions of crop growth and monitor the environment; further, the system will send feedback to the server for big data analysis and for farmers to understand the optimal environmental factors for growing the crop. The literature [6] mainly focuses on the intelligent irrigation system and the detection system of plant diseases and pest control; it uses the intelligent irrigation system to implement water resource control and avoid water waste, as well as using sonar technique to check whether the farmland has holes underneath the surface to judge if there are pests in the soil. The intelligent agricultural platform suggested by literature [7] demonstrates the data collection method of farmland while literature [8] offers an Internet security protection for the intelligent agricultural system to enhance the security level of the system.

The research presents an intelligent agricultural system based on LSTM. Due to the shortages of electricity and water resources in outdoor farms, it is necessary to develop intelligent agriculture for controlling water resources and saving electricity. The features listed in this study are 1. saving electricity via solar power systems, farmers do not need to rewire electrical equipment; 2. using sensors to detect farm environments and judge whether the environment is suitable for the crop to grow; 3. utilizing LSTM to estimate the initiating time and decrease electricity waste; 4. Developing weather forecast and historical records for estimation and to improve the forecast accuracy of LSTM. The experimental results have proved the method is feasible and is beneficial for controlling water resources and electricity.

2 The Proposed Scheme

2.1 System Model

The intelligent agricultural system based on LSTM provided by this research conducts intelligent agriculture IoT to detect the environment; the IoT system will deliver data back to the server, combining with the weather forecast information, for calculating the weather impact on the farmland and predicting the initiating time of IoT to save power and avoid energy waste (Fig. 1).

2.2 Long Short-Term Memory (LSTM) Algorithm

The study implements LSTM for soil and temperature prediction. Due to the lack of electricity and water resources in farmland, it is vital to monitor and control the intelligent agricultural system. The system offered in this article saves electricity via solar

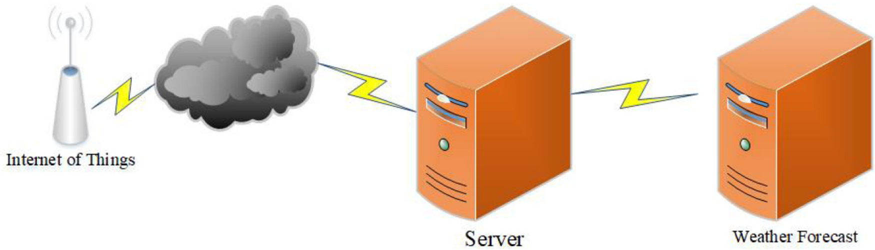

Fig. 1. System illustration.

power; yet, the IoT system could not operate all the time under limited power. To avoid exhausting electricity and lead failure of initiating the IoT system, the server is set to save weather forecast information and combine the temperature and soil humidity collected by the IoT system to conduct analyses. Inputting the current farmland temperature, soil humidity, and weather information to start the calculation of Sigmoid, the results will be a value between 0 and 1. Afterward, the output layer value will also be a number between 0 and 1. When the predicted soil humidity or the temperature is about to reach the critical value of the environment for growing the crop, the IoT system will be power up. With the LSTM function to estimate the initiating time, the initiating times of the IoT system could be effectively controlled and lower the possibility of electricity waste (Fig. 2).

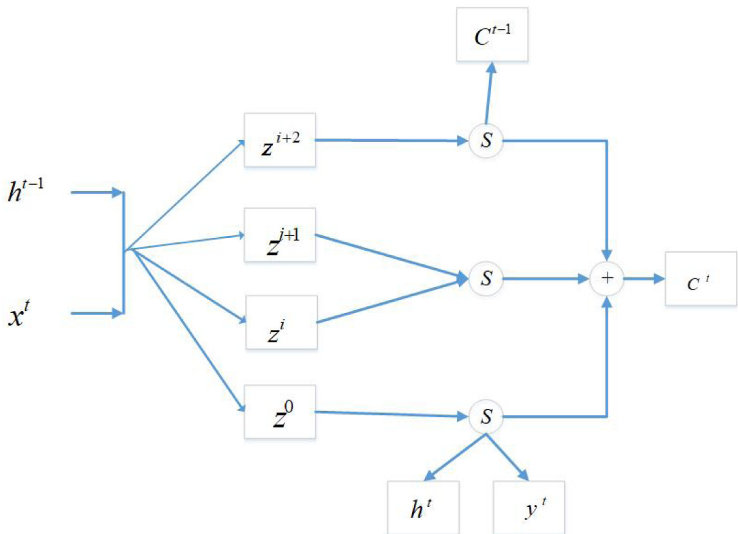

Fig. 2. LSTM model.

3 Experimental Results

The article suggested a method to build the system and test it. Figure 3 shows the hardware used in the system, Fig. 4 demonstrates the experimental field, Fig. 5 is the IoT platform, Fig. 6 presents the LSTM experiment, and the LSTM prediction curve is shown in Fig. 7. Furthermore, Fig. 5 uses XMPP to collect IoT packet information; Fig. 6 and Fig. 7 utilize LSTM to predict farm environments. The server uses the prediction to deliver commands to the IoT system, which initiates the equipment to detect farm environments; further, the farm data will be sent back to the server for LSTM to mix real and prediction data for comparison and correction. The experimental results reveal that the methodology is feasible and could control electricity and water resources effectively. The approach in this research could also monitor the farm environment and stimulate agricultural output.

Hardware Equipment of the IoT System

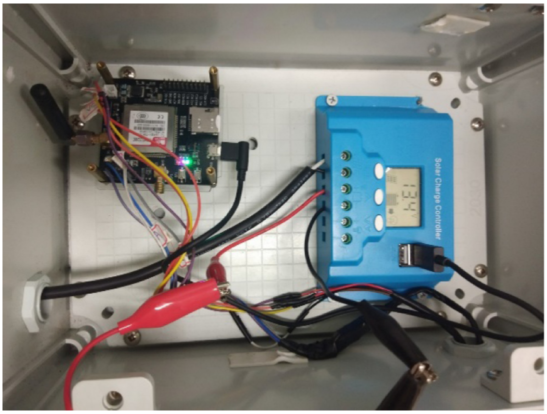

Fig. 3. Hardware equipment of the IoT system.

Fig. 4. Experimental field.

Fig. 5. The IoT platform.

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Fig. 6. LSTM experimental results.

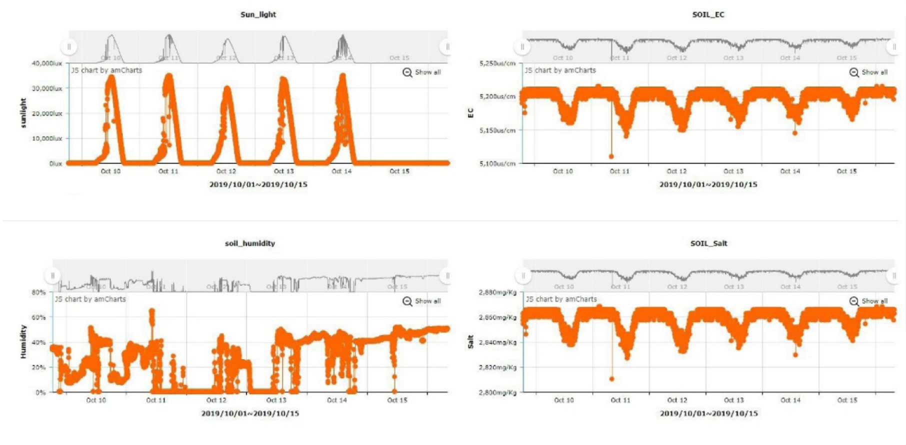

Fig. 7. LSTM prediction curve.

4 Conclusion

With the aging population trend of agricultural labor force and the impact of climate change that causes the damage of agricultural output. In terms of increasing agricultural output and decreasing the stress of agricultural labor force, the study develops an intelligent agricultural system based on LSTM that focuses on outdoor farms to cope with the shortages of electricity and water resources. Moreover, the study utilizes LSTM to predict for initiating the IoT system; through the prediction to power up the system, effectively lower electricity waste, and transfer the saved energy for controlling water resources. The method offered by this article significantly reduces the installation cost of intelligent agriculture. In the future, the methodology presented in this study could be connected with any kinds of sensor equipment, estimate data, and stimulate quality agriculture with higher selling value.

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