An Intelligent Tea Farm Management Platform Based on AgriTalk Technology

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Abstract. The production of tea is a complicated. Every aspect of tea planting requires a lot of manpower and rich experience or professional fertilizer training knowledge. Applying intelligent agricultural planting technology will effectively reduce the burden of farm operations, reduce labor demand, and enable tea farmers to operate more efficiently. The research introduces the most popular artificial intelligence (AI) technology, Internet of Things (IoT) and the AgriTalk technology to a tea farm that is located in Nantou, Taiwan. Through remotely monitoring the growth of tea and various environmental data, intelligent tea farm management platform will ensure the healthy growth of tea and increase tea production. In addition, the key patterns of tea cultivation will be established through long-term data collection and analysis. The key patterns for tea cultivation include suitable temperature, humidity, sunshine, fertilization time, etc.

Keywords: Tea planting · AgriTalk · Artificial intelligence · Internet of Things

1 Introduction

Taiwan's tea is world famous. When the tea leaves from the initial tea species to the final drop in the cup, it will form different flavors due to the climate, terrain, tea species, harvest methods, baking methods, brand marketing and other processes. The production of tea is a complicated process including tea seedling cultivation, reclamation planting, field management technology (fertilization, pesticide application, weeding, pruning, irrigation, deep ploughing, etc.), harvesting, tea making technology (withering, wavering, fermentation, blanching, cloth ball), refined baking, graded packaging, quality positioning and other technologies. Besides, different types of fertilizers are required in Taiwan's diverse topography, low to high altitude, different seasons and growth periods. The demand, element types and proportions of fertilizers for tea plants need to be more precise.

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Intelligent agriculture is already the trend of world agriculture. Intelligent agriculture emphasizes the two major issues of smart production and digital service. Through Industry 4.0 technologies such as cloud technology, big data analysis, the Internet of Things (IoT), intelligent machinery, and sensors are applied in agriculture, small farmers can reduce the impact of aging population, insufficient labor, and extreme weather on the industry. Big data database can be developed through sensors, IoT technology, collecting soil and meteorological data, recording operating methods of tea farmers and the growth trends of tea tree. Furthermore, using artificial intelligence (AI) technology to analyze related factors required for tea plant growth, such as the temperature, humidity, light, pH value, electrical conductivity (EC) value, soil fertility and carbon dioxide concentration and so on.

AgriTalk is an inexpensive IoT platform for precision farming of soil cultivation and it was proposed by W.L. Chen et al. in 2019 [1]. Related literature has adopted AgriTalk for the cultivation of turmeric, and the experimental results have improved the quality of turmeric. The curcumin concentration can be up to 5 times more than existing products. This research tries to import AgriTalk into tea farm management. As a result, assisting tea farmers can be more precise in all stages of tea production and cultivation. It is expected to effectively reduce the burden of farm operations, reduce labor demand, and enable tea farmers to operate more efficiently.

The remainder of this paper is arranged as follows. Section 2 reviews related works on intelligent agriculture, Internet of Things (IoT), and AgriTalk. Section 3 introduces the development and application of intelligent agricultural planting. Analysis and discussion for intelligent agriculture are described in Sect. 4. Finally, Sect. 5 presents conclusions and future research.

2 Related Works

Tea farm management is the main goal of this research. In this study, we must first understand the characteristics and planting methods of tea, and further propose appropriate intelligent tea farm management platform. The related works include planting and production process of tea, intelligent agriculture, Internet of Things (IoT), and AgriTalk.

2.1 Planting and Production Process of Tea

Taiwan has a variety of specialty teas from north to south. For example, there are Tiguanyin, Pouchong tea, oriental beauty tea in the north; Li-Shan Oolong Tea, Sun Moon Lake Ruby Black Tea, Dong Ding Oolong Tea in the middle and Alishan Oolong Tea, honey scent black tea, Red Oolong Tea in the south. The practical field of this research is in Lugu Township, Nantou County, Taiwan. Dong Ding Oolong Tea is the local representative tea. Dong Ding Oolong tea has a mellow taste with a hint of natural sweetness, brisk and thirst quenching. Tea farmers need to have rich experience or professional fertilizer cultivation knowledge to be able to properly and timely, appropriate fertilizer.

When planting tea, good field management is important. That includes fertilization, pesticide application, weeding, pruning, irrigation, deep ploughing, etc. In addition to

good field management, tea also needs good making technology. The tea making technology includes withering, wavering, fermentation, blanching, cloth ball and so on. In the long run, Taiwan's agriculture does need to develop intelligent agriculture and turn rules of experience into system principles. In the past, the accumulated knowledge and experience existed in the heads of experts, but now it must be translated into data and stored in the computer. In order to digitize past agricultural knowledge, more data must be accumulated to be effectively used.

2.2 Intelligent Agriculture

Intelligent agriculture is an intelligent system of agricultural experts, integrated control system of agricultural products and traceability system of organic agricultural products [5]. Based on the current production model, the production and sale plans are according to the needs of the consumer market. Production management is supplemented by the development and application of labor-saving mechanical equipment, auxiliary equipment and sensor components, combined with cross-domain ICT and materials. The introduction of forward-looking technologies such as IoT, big data analysis, and block chain reduces the burden of farm operations and reduces labor demand. Internet of things (IoT) and data-driven techniques are creating greater opportunities for smart dairy farming [6].

There are many key drivers of technology in intelligent agriculture including automation, land, water, labor resource optimization, higher food crops, quality food, climate effects [7]. Intelligent agriculture mainly uses the concept and technology of the IoT, and introduces sensing components into the existing physical objects of the farm such as agricultural machinery, agricultural facilities, soil, crops, etc., and combines wireless communication technology to collect and retrieve the sensed data upload to cloud database [2, 3]. Intelligent agriculture provides farmers with a more efficient farm management model, and produces production that meets consumer needs. Safe, secure and traceable agricultural products.

2.3 Internet of Things (IoT)

The IoT integrates several existing technologies, such as wireless sensor network (WSN), radio frequency identification (RFID), cloud computing, middleware systems, and end-user applications [7]. It is expected that by the year 2021, there will be around 28 billion connected devices [9]. The IoT empowers substantial objects to see, hear, think and perform jobs by having them "talk" with each, to share information and to synchronize pronouncements. IoT is expected to be one of the main hub between various technologies by connecting smart physical objects together and allow different applications in support of smart decision making [4]. As a result, the use of Internet of Things (IoT) and data analytics (DA) are employed to enhance the operational efficiency and productivity in the agriculture sector [7, 8].

IoT is the perfect match for smart agriculture farming and dairy farming. In the research [6], the authors proposed an IoT for development of smart dairy farming. Manual milking in a dairy farm is very time consuming and slow procedure. The preserving process of milk is also not hygienic. Manual process can cause bacterial infection in milk. IoT has solved this problem more efficiently, reducing cost and manpower, by

introducing automilking. IoT is usually adopted for solving most of present-day society issues such as smart cities, intelligent transportation, pollution monitoring, and connected healthcare, to name a few. Industrial IoT (IIoT), as a subset of IoT, covers the domains of machine-to-machine (M2M) and industrial communication technologies with automation applications [8].

2.4 AgriTalk

AgriTalk is an IoT platform for precision farming of soil cultivation and it was proposed by W.L. Chen et al. in 2019. The name "AgriTalk" is originated from that the nature (agriculture) always passes messages to human. However, human cannot catch the meaning of the messages through normal perception. Therefore, Chen et al. Develop AgriTalk that interprets the messages of the nature environment delivered to the farmers [1].

In AgriTalk, an intelligent agriculture platform for soil cultivation with a large number of sensors, the produced sensor data are used in several AI models to provide precise farming for soil microbiome and fertility, disease regulation, irrigation regulation, and pest regulation. The correct use of sensor data in AI modeling is very important. In the research [10], the authors proposed a solution called SensorTalk to automatically detect potential sensor failures and calibrate the aging sensors semi-automatically.

3 Development and Application of Intelligent Agricultural Planting

Ding Oolong Tea is the local representative tea in Lugu Township, Nantou County, Taiwan. The research developed and applied an intelligent agricultural planting technology based on AgriTalk to a tea farm in Lugu Township, Nantou County, Taiwan. The appearance of the original tea farm in Nantou County is illustrated in Fig. 1(1). The circle in the picture represents the automatic sprinkler equipment.

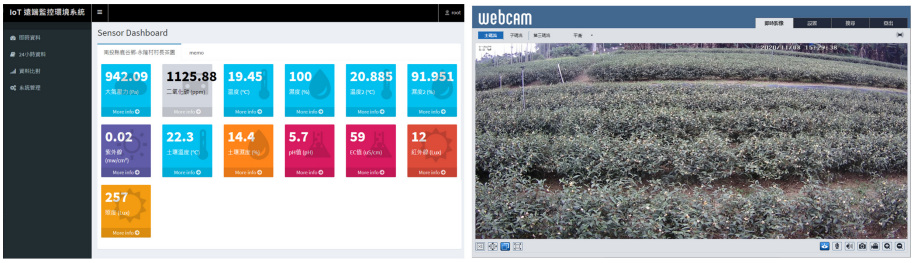
The research adopted AgriTalk platform to developing the IoT remote monitoring environment system on tea farm is illustrated in Fig. 1(2). The Position (a), (b), and (c) in Fig. 1(2) are the agricultural control module, sensors module, and IP camera.

The sensor dashboard of the IoT remote monitoring system on tea farm is illustrated as the Fig. 2(1). The sensor data include atmospheric pressure, carbon dioxide, sunlight, ultraviolet, infrared, air temperature, air humidity, soil temperature, soil humidity, pH value, electrical conductivity (EC) value, and so on. The real image from the Internet protocol camera (IPC) is illustrated in Fig. 2(2).

Because of temperature changes, whether it is raining or watering, soil fertilization or spraying pesticides, we can use historical data analysis to find the value changes shown in Fig. 3. The sensor values of CO_2, luminance, pH value, electrical conductivity (EC) value, air temperature, soil temperature, air humidity, and soil moisture are illustrated in Fig. 3(1)–(8).

This research further uses the IoT remote monitoring environment system to compare the changes of two different values. The magnitude of change of the two values pH value and EC value in the same period is shown in Fig. 4.

Fig. 1. (1) The appearance of the original tea farm in Nantou county; (2) Developing IoT remote monitoring system on tea farm based on AgriTalk



(1) (2)

Fig. 2. (1) IoT remote monitoring environment system; (2) Real image from internet protocol camera

Through data analysis, researchers can find large changes in sensor data. The researcher further discussed possible reasons with tea farmers. Confirm whether the tea farmer has sprayed pesticides, sprayed organic weeding, manual weeding, tea tree pruning, etc. Through this learning process, it will help to establish a suitable tea planting pattern with AI technology.

4 Analysis and Discussion

In this study, an IoT remote monitoring environment system was actually installed in the tea farm in Nantou County, Taiwan. However, only six months of data have been collected so far, which is not enough to produce a complete tea planting pattern. The relevant analysis and discuss are described in the following:

- **Disadvantage:** for farmers, tea farmers are familiar with the original way of working. For the initial stage of introducing intelligent agriculture, it is necessary to meet the

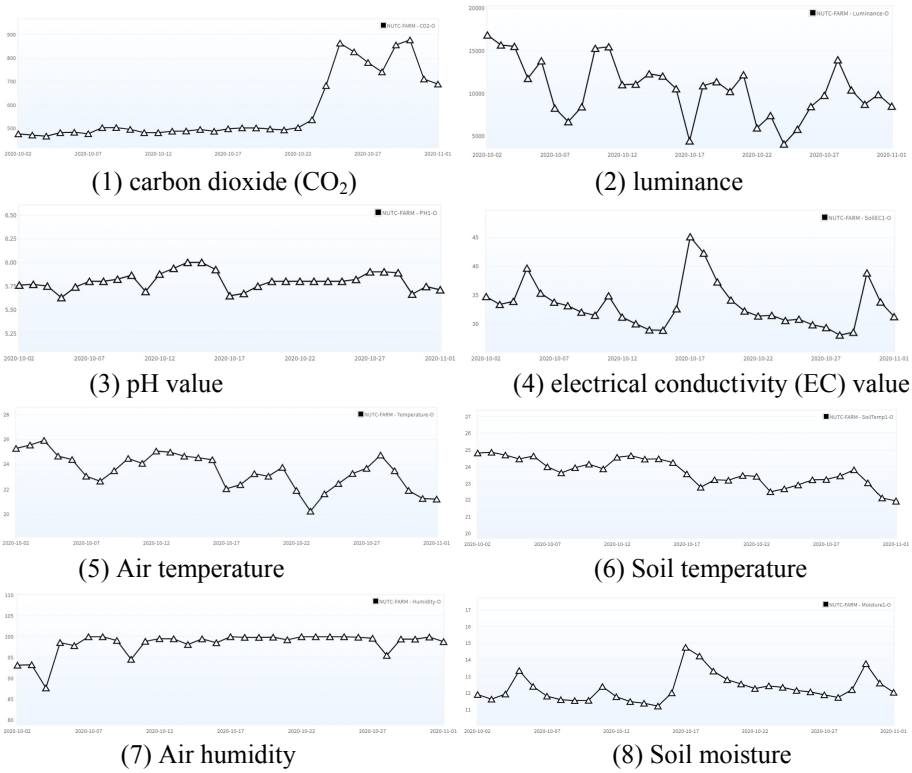


Fig. 3. The sensor values from history data query.

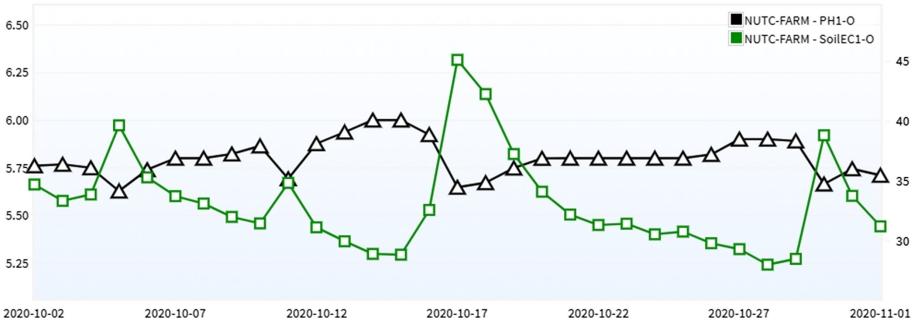


Fig. 4. Compare two sensor values from history data query.

needs of research and record related operations. This is an extra burden for tea farmers. Besides, the tea farmer ignores the physical circuit of the sensor and breaks the circuit when weeding.

- **Advantage:** Taiwan's agriculture is facing the problems of farmer aging, lack of labor, global competition and climate change. If the planting pattern of tea can be established completely, it will help small farmer sustainable development.

5 Conclusion and Future Works

This research helped a tea farmer in Nantou County, Taiwan introduce intelligent agriculture for six months. The remote monitoring environment system is based on AgriTalk. The production of tea is a complicated process including tea seedling cultivation, reclamation planting, field management technology, harvesting, tea making technology, refined baking, graded packaging, and other technologies. This research expects to continue to collect relevant sensor data and further analyze the growth data of tea. At different altitudes, the suitable temperature, humidity, illuminance, pH value and EC value of tea should be different. This research hopes to complete the establishment of tea growth pattern, and hopes to help tea farmers better manage tea farms in the future.

In the future, this research also hopes to develop an intelligent tea selection. There are thousands of participants in the annual tea competition held in Taiwan. This research hopes to collect all kinds of tea soup colors and automated tea selection operation through machine learning.

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