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AI-BASED Monitoring Of New Plant Growth Management System Design

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Abstract

This paper deals with research on innovative systems using Python-based artificial intelligence technology in the field of plant growth monitoring. The importance of monitoring and analyzing the health status and growth environment of plants in real time contributes to improving the efficiency and quality of crop production. This paper proposes a method of processing and analyzing plant image data using computer vision and deep learning technologies.

The system was implemented using Python language and the main deep learning framework, TensorFlow, PyTorch. A camera system that monitors plants in real time acquires image data and provides it as input to a deep neural network model.

This model was used to determine the growth state of plants, the presence of pests, and nutritional status.

The proposed system provides users with information on plant state changes in real time by providing monitoring results in the form of visual or notification. In addition, it is also used to predict future growth conditions or anomalies by building data analysis and prediction models based on the collected data.

This paper is about the design and implementation of Python-based plant growth monitoring systems, data processing and analysis methods, and is expected to contribute to important research areas for improving plant production efficiency and reducing resource consumption.

Keywords: *Image Data, AI(Artificial Intelligence), Agricultural, Agricultural Industries , Data Analysis, Data Prediction*

1. Introduction

Artificial intelligence (AI)-based plant growth monitoring system is a high-tech technology that

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continuously tracks plant growth and conditions and provides optimal conditions for them, and can be applied to various fields such as agriculture, greenhouse management, and urban agriculture.

In this paper, we introduce a system that alerts users and promotes plant growth management through apps that have developed analysis results along with real-time image processing.

2. Research Scope

Insufficient data results in inaccurate analysis of learning data adversely affect plants, and the current system does not respond perfectly immediately.

Various sensors and cameras still require huge costs and it is difficult to introduce a system.

Therefore, it is difficult to collect a lot of data needed for plant growth, and the aforementioned misleading data analysis results significantly reduce the efficiency of the system.

In addition, the aging of farmers is intensifying, and the number of farmers is rapidly decreasing, which is causing problems in the introduction of technology.

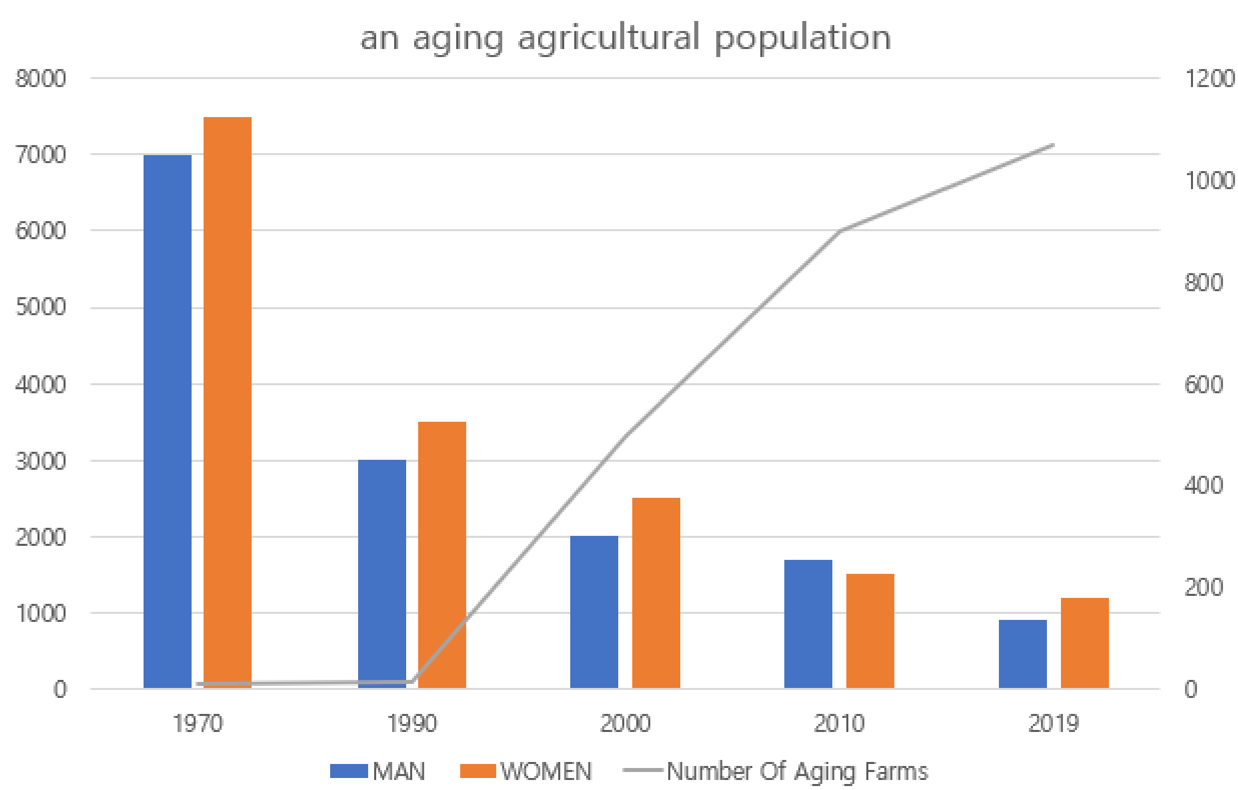

Figure 1. the aging index of the nation's agricultural population

The analysis of farm data was prepared by collecting and analyzing data on farms subject to the past 50 years (1970-2019) provided by the Agricultural Promotion Agency and analyzing the population engaged in agriculture, and the aging data of farms are shown in Picture 1.

3. Data Analysis and Verification Method

The artificial intelligence-based plant growth monitoring system proposed in this paper processes and analyzes real-time images through cameras, and collects the analyzed data and uses it for future data analysis.

It learns various patterns such as growth patterns of various plants, color changes, and pest detection, and sends FCM (Firebase Cloud Messaging) notifications to users to the smartphone app to immediately suggest necessary responses.

Through Raspberry Pi, Camera, Python programming
Image classification and analysis are conducted using convolutional neural network (CNN)-based models.

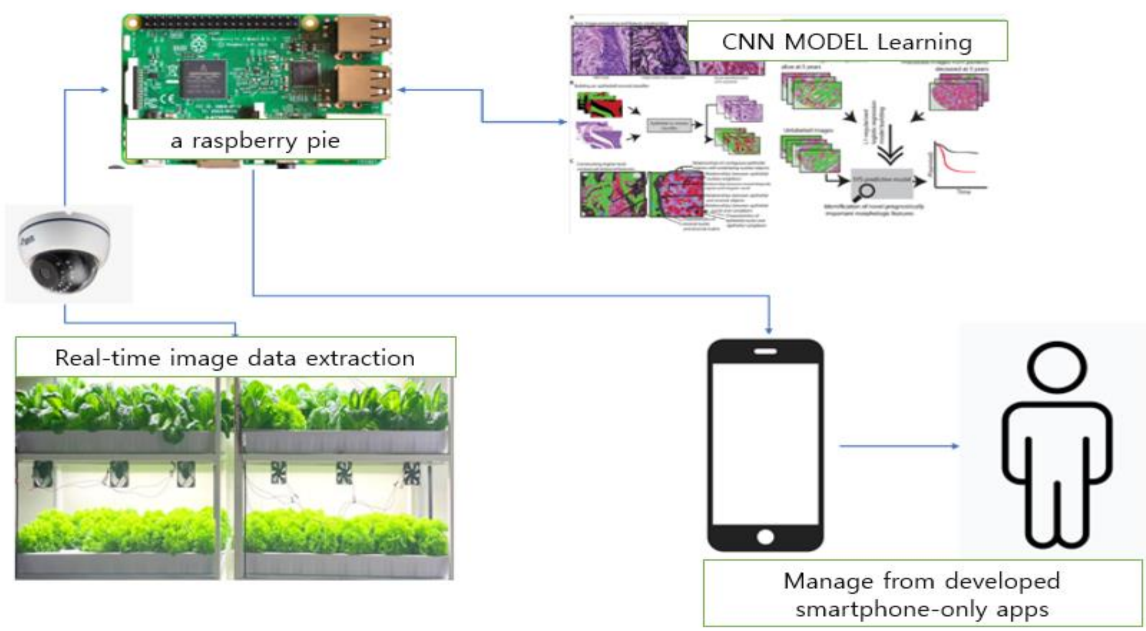

Figure 2. Configuring an artificial intelligence-based plant

Figure 2 is a technology implementation diagram of the IoT management system proposed in this paper. Image data extracted in real time after linking the camera using Raspberry Pi is learned by the CNN model. After that, based on the learned results, FCM information and how to manage plants are guided to the app where information on plants is currently developed to induce a more active response.

4. Development Environment and System Implementation

It is designed through the following development environment to implement the artificial intelligence-based plant growth monitoring system proposed in this paper.
The OS environment is Windows64bit, and the development tools are Android Studio, Xcode, Pycharm, IntelliJ IDEA, and opencv. The languages used in the development are implemented in Java, JavaScript, Swift, Python, and XML, the web server uses a spring boot, and the DataBase uses MYSQL DB.

```python
if self.soil_moisture < 30:
    feedback.append("Plants need water.")
elif self.soil_moisture > 70:
    feedback.append("The soil is too wet.")

if self.light_intensity < 30:
    feedback.append("Plants need more light.")
elif self.light_intensity > 80:
    feedback.append("Reduce the light on the plants.")

# 온도 조건 분석
if self.temperature < 15:
    feedback.append("The temperature is too low.")
elif self.temperature > 28:
    feedback.append("The temperature is too high.")

return feedback
```

Figure 3. Analyze data using sensors code

Figure 3 is Sensor data collection: utilizes sensor data connected to the Raspberry Pi. Data Analysis: Analyze central data to determine the state of the factory. Provide feedback: Determine and output actions based on the analyzed data.

```python
train_gen = datagen.flow_from_directory(
    data_path,
    target_size=img_size,
    batch_size=batch_size,
    class_mode='categorical',
    subset='training'
)
val_gen = datagen.flow_from_directory(
    data_path,
    target_size=img_size,
    batch_size=batch_size,
    class_mode='categorical',
    subset='validation'
)
#CNN Model
model = Sequential([
    Conv2D(32, (3,3), activation='relu', input_shape=(150, 150, 3)),
    MaxPooling2D(2, 2),
    Conv2D(64, (3,3), activation='relu'),
    MaxPooling2D(2, 2),
    Flatten(),
    Dense(128, activation='relu'),
    Dense(train_gen.num_classes, activation='softmax')
])

model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

# model Learning
model.fit(train_gen, validation_data=val_gen, epochs=10)

# model save
model.save('plant_growth_model.h5')
```

Figure 4. Temperature forecast graph of pyeongtaek-si

The code in Figure 4 is a code that stores a model after learning using a CNN model based on data extracted in real time. This is a very important process and analyzes the results of real-time image data extracted in the future more accurately and clearly. In this paper, a real-time image processing model was produced and plant growth is monitored with the model.

5. Conclusions

In this paper, the combination of Python and artificial intelligence technologies for monitoring crop growth is leading innovation in the agricultural sector. It improves crop productivity through accurate data analysis and real-time monitoring, reduces farmers' burden through automated systems, and contributes to realizing sustainable agriculture. Furthermore, through more advanced artificial intelligence technology, crop growth monitoring is expected to evolve in a more sophisticated and efficient direction.

Further research should be conducted for more accurate analysis results through the collection of a lot of data in the future.

In addition, various functions such as plant growth patterns, pest detection, and water shortage detection over time should be added to expand the system and further improve performance by utilizing techniques such as deep learning and transfer learning.

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