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Ways to Achieve Efficiency Using Convolutional Neural Network in Cotton Growth

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Annotation: The article presents data on the creation of an algorithmic program based on convolutional neural network and through it the optimal time of application of cotton plant against diseases and pests is determined. In order to save costs and improve efficiency, the theoretical considerations aimed at the formation of a database based on images and data and the development of a convolutional image recognition neural network and a cost calculation model.

Key words: fine fiber cotton varieties, neural network, cotton cultivation, mathematical modeling, spraying, convolutional imaging, software, productivity.

Today, the demand for quality cotton fiber is increasing worldwide. In the international cotton market, the fiber of cotton varieties belonging to the type of fine fiber G. barbadense L. is valued more expensive than the fiber of medium fiber varieties. From one ton of fiber of this type, several times more gauze is spun, and the price is also high [7]. In our republic, in 2001, the cultivated area of thin-fiber cotton varieties was 23 thousand hectares, and by 2008, thin-fiber varieties Termiz-31, Surkhan-9 and Surkhan-14 were planted on an area of only 6.5 thousand hectares [5]. In the years of independence in Uzbekistan, the number of textile enterprises processing thin-fiber fiber, the number of high-quality finished products, strong yarns for the domestic and foreign markets, increased [6]. Due to the shortage of fine fiber in the world, the cultivated area of Pima varieties (G. barbadense L.) has increased from 80 thousand to 110 thousand hectares. India buys an additional 150,000 tons of Pima fiber in addition to its fine fiber varieties [6].

The cultivation area in Uzbekistan is expanding year by year, and the creation of high-quality and high-yield varieties of fine-fiber cotton of the G. barbadense L. type, which is somewhat superior to medium-fiber cotton in terms of fiber quality indicators, disease and pest resistance, is one of the most urgent tasks of the cotton industry of our republic.

Cotton is damaged by 214 species of invertebrates. 207 of these are arthropods, including 203 - spider mites, aphids, autumn moths, caradrina, cotton moths and similar insects. Cotton is affected by verticillosis and fusarium wilt, gommosis, root rot and other diseases. There are 74 types of weeds in cotton fields, such as (ajriq)Cynodon dactylon, (gumay) Sorghum, (qoypechak) Convolvulus arvensis, (itqonoq) Setaria, (qora kurmak) Echinochloa macrocarpa Vasing and others are found. Agrotechnical, biological, chemical protection methods are used in pest control with mechanical and chemical methods against weeds.

Various studies have shown that the optimal time for spraying agricultural crops against diseases and pests is different, and certain periods of plant growth have different effects on the effectiveness of spraying. The types of disease and pest control products that should be used during different growing seasons are also different.

Foreign scientists Zoltan Zeman, Akos Barta, Gergo Thalmeiner, Sandor Gaspar carried out scientific research on the use of remote methods for the automation of management of agricultural crops, systematic analysis and mathematical modeling methods, and the development of

monitoring systems using computer technology [1, 2, 3, 4]. However, the technology envisaged in the ongoing project differs from foreign analogues.

Our research on the cotton plant is related to cotton growing time, temperature, soil moisture and sunlight duration. It is very difficult to determine the growth status of cotton only by calculating the time of planting. In addition, cotton has a long growing season and is subject to many diseases and pests throughout the growing season. As a result, economic losses occur due to multiple applications of disease and pest control. Thus, achieving optimal timing of disease and pest control can save costs and increase efficiency. Therefore, recognition of the growth period by images and medication based on them leads to a higher level of efficiency than the previously used (calculated from the date of planting) medication method.

This efficiency can be achieved by creating an algorithmic program based on a convolutional neural network. This software is a method used to study the growing season through image processing and to determine the optimal timing of medication during the growing season. That is, convolutional neural networks of plant development are an improved version of artificial neural networks. One of the most important advantages of a neural network based on convolutional image recognition is that it can be reliably analyzed even with less and older data. The system analyzes the plant according to its external characteristics, laboratory analysis is also important during the research, because it helps to study the effect of pests on plants. And this allows the neural network to detect external plant signals that can be used to support its "knowledge". This will cause the program to improve and work more accurately.

This program allows image recognition systems to accurately, efficiently and quickly determine plant growth periods in digital form. Neural network imaging is based on a process that requires the compilation of large volumes of images and several different laboratory analyses. A database is created by entering images and laboratory analysis. After the process of learning the images, the neural network can recognize the images in the digitized form. Photos must always meet the neural network's pre-defined criteria to allow the database to adequately learn how to use the data further. Data acquisition is performed throughout the plant's development by taking hundreds of images at each growth phase of the cotton plant. After entering the obtained images into a neural network and creating a database, the program creates an algorithm for the plant's physiological development, and in this way, it will be possible to estimate the optimal time of spraying in which phase of the plant's development. Thus, by applying this program, cotton cultivation can be made more efficient, which ensures more sustainable production.

In our research, we develop software that includes a convolutional neural network-based image recognition algorithm. With this high level of reliability (95% <), this algorithm can dynamically recognize the growth phases of cotton crops. By predicting these effects and accurately studying the cost implications, a model is created that optimizes the spraying efficiency of different plots. In addition, it will be possible to achieve cost effects, expected cost effects and cost optimization. In addition, by spraying at the optimal time for the life stage of the plants, it is possible to achieve more sustainable crop production, which allows to reduce the quantitative application of chemicals and the number of spraying operations.

In order to implement the above, an interrelated project is being implemented in cooperation with the Karshi Institute of Engineering and Economics and the Hungarian University of Agriculture and Natural Sciences. The project is based on two parties performing different research tasks in their country and summarizing the results to create a final algorithm network.

The project at different stages:

1. Determination of plant characteristics from the point of view of cotton planting and spraying, taking pictures (including laboratory tests);

2. Creating a database based on images and data, and developing a neural network for convolutional image recognition and a cost calculation model;

3. Includes the creation of an IT system.

As mentioned, the research of both parties is interrelated and the parties have defined tasks. We, a team of Uzbek researchers, are responsible for the first stage of the project classification, i.e. planting cotton, taking hundreds of images at different stages of development, multiple treatments at different stages, and providing high-precision laboratory analyzes to the Hungarian side.

The Hungarian side will coordinate the implementation of the project, that is, the creation of a database based on the information and images sent by Uzbek researchers, and the development of a neural network for convolutional image recognition and a cost calculation model. The mission of the research team is to participate in identifying the various life cycles of cotton associated with spraying. In addition, special attention is paid to the identification of diseases and pests that appear in different life cycles and the necessary methods of protecting plants against them, especially to the mapping of the optimization of the spraying process.








We took many pictures of different stages of cotton development, and based on the images, we used a neural network to learn what plant physiological characteristics are present at each stage of development. Based on these features and teachings, the image recognition neural network is able to tell the developmental stage of this plant based on a single photo. Thus, based on continuous imaging, an image recognition neural network tells us at which developmental phase and time is the best time to medicate a given region.

The software we develop is unique because each neural network is developed in its own way. But the evolving logic is the same as the neural networks used in the harvesting process. This is because our goal is not to innovate the methodologies of image recognition networks, but to apply and implement them.

Thus, we are reforming the neural networks used in crop harvesting to improve spraying efficiency. A similar program exists for harvesting operations in horticulture, and we are developing it for the first time in spraying.

At the same time, their use in the production of field crops is not yet widespread enough, and the determination of the time of spraying depending on the physiological development of the plant has not yet been established. The system developed in this way is not only a new scientific result, but also serves as a digitized system that supports business entities operating in agriculture in the transition to precision farming.

In other words, the neural networks of image recognition make it possible to determine the stages of plant development and thereby create the possibility of protection at the optimal time.

In addition, by using this neural network-based systematic algorithm in the field of agriculture, it is possible to provide high-quality food products free of harmful chemicals for the human body that meet the global demand, which is one of the most urgent topics today, by reducing the use of chemical drugs several times. allows to ensure food safety.

By predicting the cost impact of disease and pest control as a function of different plant life stages and area coverage, spraying costs can be reduced and production losses can be minimized. The purpose of the developed software is to improve spraying efficiency, which can lead to increased production while reducing costs. It allows to increase the profitability of local businesses using software. With our research, we support increasing the level of digitalization and precision

farming solutions used in small-scale horticulture in Hungary. The software developed on the basis of the project is suitable for increasing the efficiency of farming in small plots of land by implementing digitization development with low investment costs. In addition, spraying at the optimal time for the life of the crops in the production area helps to produce a more stable crop, which can reduce the amount of chemicals used and the number of spraying operations. Thus, it also contributes to the development of the professional knowledge and skills of the human resources employed in the sector, which can provide high added value and thereby increase the level of income.

With the development of software, it is possible to increase the average yield of cotton, thereby reducing the area of cotton cultivation. By increasing planting efficiency and average yield, it contributes to reducing the significant environmental burden of cotton cultivation. Once the developed program achieves the expected result, it can be used to grow a number of field crops.

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