Journal of Artificial Intelligence Practice (2023)
Clausius Scientific Press, Canada

DOI: 10.23977/jaip.2023.060811
ISSN 2371-8412 Vol. 6 Num. 8

Tomato picking robot based on deep learning

Zhenyu Wang, Hongyuan Zhu

School of Electronic and Information Engineering, University of Science and Technology Liaoning, Anshan, 114051, China

Keywords: Deep learning; Picking robot; ESP8266

Abstract: In this paper, a comprehensive tomato picking robot system based on deep learning is designed according to the shortcomings and shortcomings of the existing picking robots. The robot can check the maturity of the tomatoes in the field of vision at one time and continuously pick the tomatoes. In terms of mobility, it can realize a wide range of autonomous movement, and can upload the growth situation of tomatoes through the cloud in real time. In addition, the system can also be developed again and applied to other agricultural products, which has certain practical value.

1. Project research background

Tomatoes are an important crop that is widely grown and consumed around the world. However, the tomato picking process is often a time-consuming and onerous task with high demands on human resources. In order to improve the efficiency of tomato picking and reduce the labor burden, researchers began to explore the use of robot technology to achieve automated tomato picking. As an important branch of artificial intelligence, deep learning has made remarkable progress in image recognition, object detection and motion planning in recent years. Its powerful pattern recognition and learning capabilities make it ideal for designing and developing robotic systems[1]. The tomato picking robot based on deep learning aims to use deep learning algorithms to automate the tomato picking process through image recognition, target positioning and precise control. Therefore, this project aims to realize the design and implementation of tomato picking robot through deep learning technology, so as to solve the limitations of traditional picking methods. If robots replace people to complete part or even all of the tomato picking work, not only greatly reduce the cost of picking, but also solve the problem of labor shortage, and further enhance the degree of intelligence in agriculture[2].

2. Research status at home and abroad

In recent years, robot research based on deep learning has been widely concerned and explored. With the continuous progress of deep learning algorithms, it also provides a more feasible solution for robots to realize automatic picking. There are many kinds of picking robots abroad. In addition to China, other countries have also made many important progress in the research of tomato picking robots based on deep learning, such as the apple picking robot developed in South Korea and Belgium, the strawberry picking robot developed in Japan, the Virgo company of APPHarvest in the United States, and the orbital cucumber picking robot developed in the Netherlands. Some universities and

research institutions abroad have carried out in-depth research in the field of agricultural robots. With the help of deep learning technology, they explore efficient and accurate tomato picking methods through a combination of machine vision and robot control[3].

Domestically, China has been a world leader in research and technological development in the field of agriculture, so its research in tomato-picking robots based on deep learning has also shown strong strength. Many domestic experts and scholars actively explore how to apply deep learning technology to the design and development of agricultural robots. They are dedicated to solving serious tomato picking problems, including complex tomato morphology, robot motion control and environmental perception.

Although there has been a lot of substantial progress in the research of tomato picking robots at home and abroad, the actual tomato picking environment is complicated and changeable, and many robots are easy to be interfered by environmental factors, which is difficult to meet the actual picking needs. Therefore, there is an urgent need for an intelligent tomato picking robot that can reduce interference, identify fruit quality and have high degrees of freedom.

3. Integrated System Design

3.1 Design of the Hardware in the System

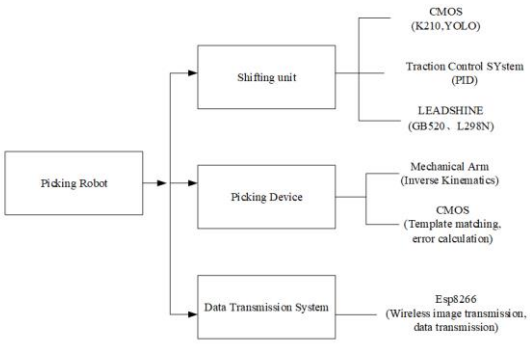

Figure 1: Overall design of the system

As shown in Figure 1, the system is divided into three parts. The first part is a mobile device, the main function is to allow the device to move freely in the field or greenhouse. The second part is the picking device, the main function is to control the robot arm to pick tomatoes. The third part is the data transmission device, the main function is to pick the number, tomato maturity region information, growth and other data reported to the host computer through the WIFI module, but also wireless image transmission, to achieve the effect of monitoring.

3.2 Extraction of tomato fruit characteristics

In the actual picking process, irrelevant factors such as crop background and cover of branches and leaves seriously interfere with the acquisition of information, resulting in errors in the recognition of picking machines, reduced success rate of information screening and differentiation, and errors in the recognition of good and bad fruits. Therefore, in order to avoid the influence of the above factors and obtain a more accurate recognition neural network model, we trained the tomato fruit, tomato vine and leaf together to ensure the generalization performance of the model.

On the other hand, there is a great difference between the color of ripe tomatoes and their stems and leaves. The color can be compared directly in the RGB three color channels. At the same time, it is necessary to extract the features of the shapes of tomato stems and leaves, and the shapes of fruit, stems and leaves are significantly different. Neural networks are a kind of machine learning method

that simulates the operation of neurons in living organisms. The algorithm consists of multiple convolution layers, each of which contains multiple convolution nuclei. Scan the entire image from left to right, top to bottom, and get an output called an element. The convolutional layer at the front end of the network captures the local details of the image, while the area occupied by each pixel in the output image is small. In the subsequent domain of convolutional layer identification, the identification range of these regions is gradually extended to capture increasingly abstract image information. Finally, multiple convolution layers are calculated to obtain images of different scales.The K210's audio and audio integration design gives it mechanical vision and hearing capabilities. It has high low power vision processing speed and accuracy, and has KPU convolutional artificial neural network hardware acceleration. The accuracy of the model is higher and the probability of misjudgment is lower by identifying the tomato with multi-dimensional features.

The power supply part is controlled by DC-DC numerical control, and the buck function module is a full-digital display system with small volume, large power consumption, high efficiency, reasonable structure, sufficient materials and stable working environment. The high speed single chip microcomputer is used for calculation, and the output current and voltage can be adjusted accurately. Built-in ten memory, can be stored at any time, call parameters, simple operation. Four-digit eight-segment LED digital tube can display voltage, current, power, capacity and other parameters in real time. In addition, the system also has automatic control after power-on, wheel display parameters and other functions, can be switched according to the actual needs of students. The ADP2300 and ADP2301 are available in a variety of input voltages, from 3 V to 20 V, for a wide range of applications, including consumer, industrial and communications. Output voltage in 0 range. 8 V regulation to 90% input voltage. The AD2300 and AD2301 use current control mode, fixed operating frequency PWM structure, and pulse width modulation structure respectively, which makes the company excellent in stable and transient response. In low load conditions, to reduce low load losses, these regulators operate automatically in PFM mode. Built-in compensation and soft start, not only convenient design, but also save PCB space; Adaptive pulse frequency modulation technology is adopted, which improves working efficiency under low load conditions, accurately activates the plug, and can work from the exact input voltage [4].

The visual inspection display screen for the completion is a 3.5-inch TFTLCD LCD module. TFTLCD is a thin film transistor type liquid crystal display with good brightness, high contrast, strong sense of layer, bright color of screen information, and high safety and reliability [5]. The screen displays the completion status, the number of grabs, and the estimated completion time in real time, which is convenient for operators to observe. The schematic diagram is shown in Figure 2.

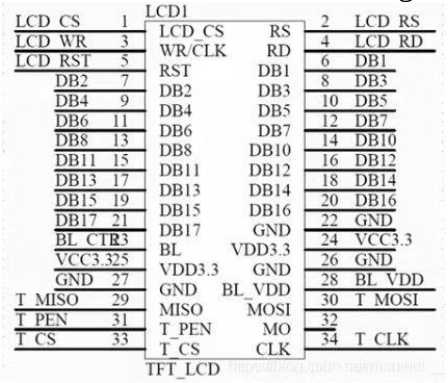

Figure 2: Schematic diagram of TFTLCD LCD module

The alarm device uses two alarm modes: led light and buzzer. When there is a problem in the process of infusion, the system will alarm. Add a resistor to the LED, which can reduce the current value and play a protective role. When the MCU implements alarm function. Due to the action of the

resistance, the output is low, the led light and the buzzer work at the same time to carry out the alarm task, the buzzer alarm circuit schematic diagram is shown in Figure 3.

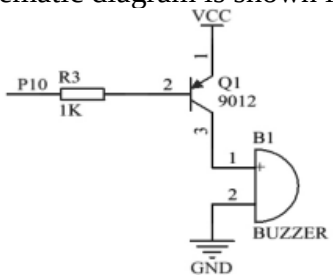

Figure 3: Schematic diagram of buzzer alarm circuit

About the data transmission device, wireless communication technology is divided into long distance wireless communication technology and short distance wireless communication technology according to the length of its communication distance. There are many types of commonly used long-distance wireless communication methods, such as satellite communication, microwave communication, UM communication, etc., and commonly used short-distance wireless communication such as Bluetooth communication, short-wave communication, etc. Microwave communication and short wave communication need to set up base stations, the cost is high; Satellite communications are also expensive; Therefore, the wireless communication method chosen in this study is GPRS communication. This paper takes ESPWIFI as the main control module, which can realize the wireless image transmission function. When the robot is working, the ESP module can transmit real-time images to the cloud, view the transmitted images according to the corresponding web address, and supervise the working status of the robot. At the same time, the ESP module needs to make data statistics on the maturity of tomatoes identified by the camera, calculate and analyze the maturity of tomatoes in each area of the tomato field, and report it to the host computer. At the same time, the ESP module can also upload the growth condition detected by the camera or other sensors of the tomato tree to the host computer. Users can check the growth of the tomato field at any time.

4. Conclusion

According to the analysis of the current research status of tomato picking robot, this paper finds that there are many shortcomings and deficiencies in the existing picking robot technology. Therefore, this paper designs a set of tomato picking robot system based on deep learning to solve these problems. The robot can check the maturity of the tomatoes in the field of vision at one time and continuously pick tomatoes. In terms of mobility, it can realize a large range of autonomous movement, and can upload the growth situation of tomatoes through the cloud in real time. In addition, the system can also be developed again and applied to other agricultural products. To sum up, the picking robot designed in this paper has certain practical significance and has certain popularization value.

References

[1] Yang Leping, Wang Jiaze, Zhu Xuanren, Zhang Jiantao, He Bin, Liu Shihui, Huang Yun, Zhai Binliang. Modular design and analysis of tomato picking Robot [J]. Chinese Science and Technology Papers, 2023, 18(02):215-223.
[2] Zhu Zhiwei. Research on fruit recognition and localization technology of tomato picking robot [D]. Hefei University of Technology, 2022.
[3] Xu Can, Xiong Zheng, Jiang Xianping, Deng Min, HUANG Guicai. Design and research of string harvesting tomato picking Robot [J]. Modern Agricultural Equipment, 2019, 42(06):15-23.
[4] Xiao Qin, Wang Xianchun, Zhou Junfan, et al. Study on the construction of gas safety system in smart home [J]. Internet of Things Technology, 2020, 10 (8): 74-75.
[5] Ren X, Li W J. PM2.5 detection system with positioning function based on STM32 [J]. Journal of Beichina Institute of Astronautics and Astronautics, 2017, 27 (5): 11-13.