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# Pet Snacks Drying Design based on PLC

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**Abstract:** With the rapid development of the pet food market, higher requirements are put forward for safe and healthy production methods of pet snacks. In this paper, a pet snack fruit and vegetable drying system based on programmable logic controller (PLC) is designed. The system takes PLC as the core, integrates automatic control technology, high-precision sensors, and TIA-Portal programming software, realizes accurate sequence control through a ladder diagram program, and automatically completes fruit and vegetable sorting and efficient drying. The themicouple sensor monitors the temperature in real-time to ensure the stability and safety of the drying quality. Factory IO simulation verification shows that the system effectively reduces labor costs, realizes the efficient and stable control of the pet snack drying process, and improves the drying effect and product quality. This study is of great significance in promoting the intelligence of the food industry and improving the efficiency and quality of the pet snack drying process.

**Keywords:** PLC; Pet Snacks Drying; Automatic Control; Temperature Control Alarm.

## 1. Introduction

The pet market is in a stage of vigorous development, and the safety and production efficiency of pet food are getting more and more attention. This study is devoted to the design of a pet snack fruit and vegetable drying system based on a programmable logic controller ( PLC ), aiming to improve production efficiency and product quality to meet the urgent needs of the market for safe and healthy pet snacks. In view of the lag of domestic fruit and vegetable drying equipment technology compared with the international level, it is particularly critical to develop an efficient, intelligent, and environmentally friendly drying system. The system relies on PLC technology and integrates control technology to realize automatic sorting and efficient drying of fruits and vegetables, as well as ensures safety through real-time temperature monitoring. Promote the intelligent process of food production, improve the efficiency and quality of the pet snack drying process, and then improve the level of the automated output, enriching the market supply; the system has significant market promotion potential and practical application value. [1]

## 2. Overall Design of the System

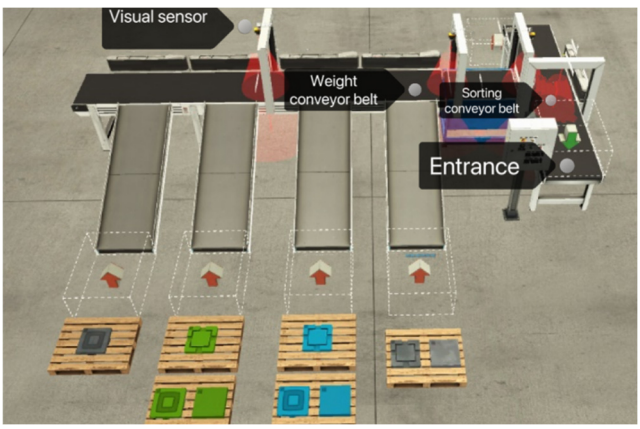


**Fig 1.** The main components of fruit and vegetable sorting

This system takes PLC as the core controller and cooperates with a temperature sensor ( thermocouple ), photoelectric sensor, visual sensor, weight sensor, heating element, dryer, conveyor belt, and simulation tool. PLC controls the functions of start/stop, screening, sorting, and drying temperature according to the preset program. The temperature sensor monitors the drying temperature to prevent overheating and alarm. The weight and photoelectric sensor accurately detects the weight and count of fruits and vegetables and realizes automatic classification and recording.

### 2.1. System Control Design

The sorting part of the system control design skillfully integrates the PLC program and various sensor technologies, including visual, weight, and photoelectric sensors, to achieve accurate identification and counting of fruits and vegetables. Driven by the conveyor belt, fruits, and vegetables are first transported to the screening area for preliminary screening to eliminate materials that do not meet the requirements. Subsequently, these fruits and vegetables continue to be transmitted to the sorting area. [2]

In the sorting process, the system first uses the identification sensor to preliminarily screen all fruits and vegetables, effectively eliminating useless materials. Then, by integrating the advanced technology of the weight sensor and recognition sensor, the system can further classify fruits and vegetables in detail. It is particularly worth mentioning that the application of visual sensors has significantly enhanced the image recognition ability of the system, enabling it to accurately identify the type and appearance characteristics of fruits and vegetables. At the same time, the accurate measurement of the weight sensor ensures the accuracy of the weight of fruits and vegetables. The two work together to promote an efficient and accurate sorting and drying process.

In the grain drying process, the drying hot air temperature is a crucial factor. It is directly related to the speed and effectiveness of fruit and vegetable drying and the quality of the final product. In view of this, a significant innovation of this system is the use of thermocouple sensors to build a temperature control alarm mechanism. As a commonly used temperature sensor, thermocouple is famous for its high precision, fast response, and excellent stability in harsh environments such as high temperature and mechanical

vibration. The sensor can monitor the temperature inside the dryer in real-time. Once the temperature exceeds the preset safety threshold, the system will automatically trigger an alarm and suspend the drying process, thus effectively preventing food burning or quality deterioration caused by excessive drying. [3]

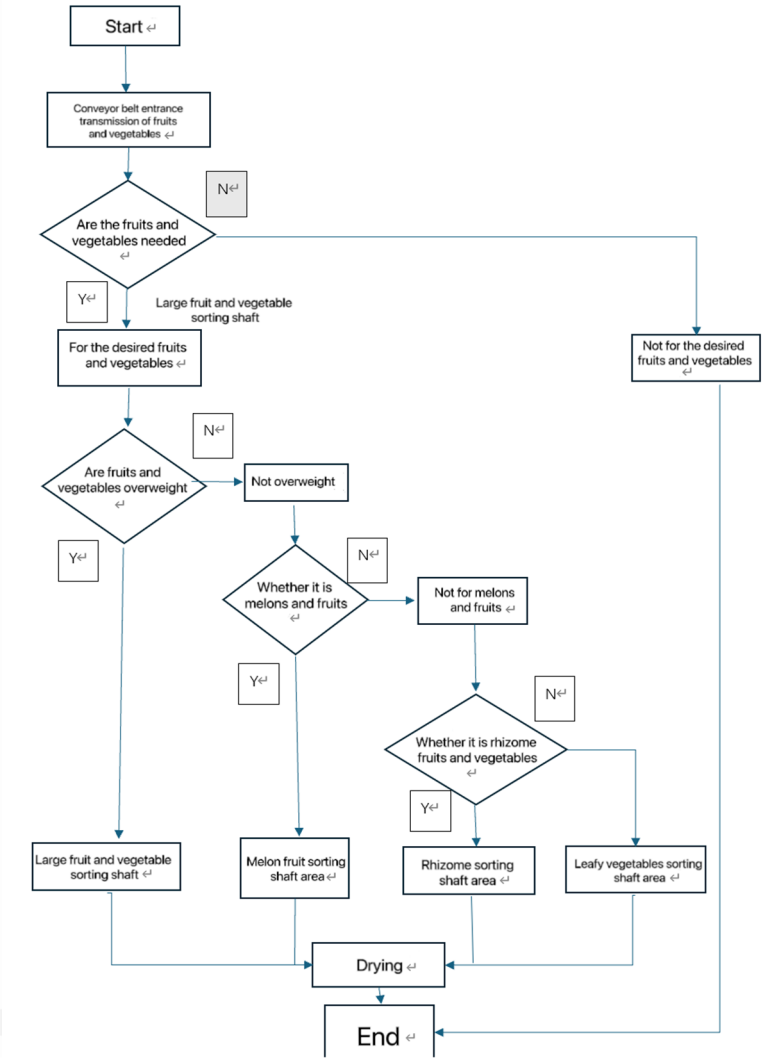


**Fig 2.** Control flow chart

Through the precise control of the temperature sensor and the synergy of the alarm mechanism, the system can ensure that the drying temperature is always maintained within an appropriate range, which not only avoids the inefficiency caused by insufficient drying but also eliminates the quality hidden dangers that may be caused by excessive drying. During the operation cycle of the dryer, whenever a round of fruit and vegetable drying operation is completed, if the system detects that the internal temperature of the dryer has reached the preset specified temperature, the alarm indicator light ( red light ) will immediately light up. At this time, the operator should immediately stop the dryer operation and wait for the internal temperature to drop to the normal range.

## 2.2. Working Principle of PLC

The PLC-integrated machine collects the signals of external equipment, such as the photoelectric limit sensor, through the digital input module, converts them into digital signals, and transmits them to the central processor for processing. According to the preset logic program, the central processor controls the execution device through the digital output module, judges the execution of the device, and controls its regular operation. At the same time, the analog input module converts the analog signal ( such as temperature and humidity ) into a digital signal for the central processor to process. The system uses Siemens S7-1200 CPU 1214C, which is more scalable and flexible, and uses SIMATIC STEP 7 Basic engineering configuration software for programming. The temperature controller and PLC realize data transmission through the RS485 communication protocol and realize accurate temperature control, as shown in the figure.

# 3. Control System Software Design

The four functional modules of screening, sorting, temperature control, and counting are verified in the simulation debugging. Identification and screening cameras accurately classify fruits and vegetables and transmit them to different sorting areas on demand. The weight sensor accurately measures the weight of fruits and vegetables to ensure that large fruits and vegetables are specially treated.[4]

## 3.1. Screening Module

Fig.4 shows the fruit and vegetable screening process in detail. After the fruits and vegetables are transmitted by the conveyor belt, they are sequentially identified by the ' Fruit and Vegetable Identification and Screening Camera ' and the ' Fruit and Vegetable Identification and Screening Camera

No.2 ' high-precision identification to ensure that they are accurately sorted to the corresponding processing area.

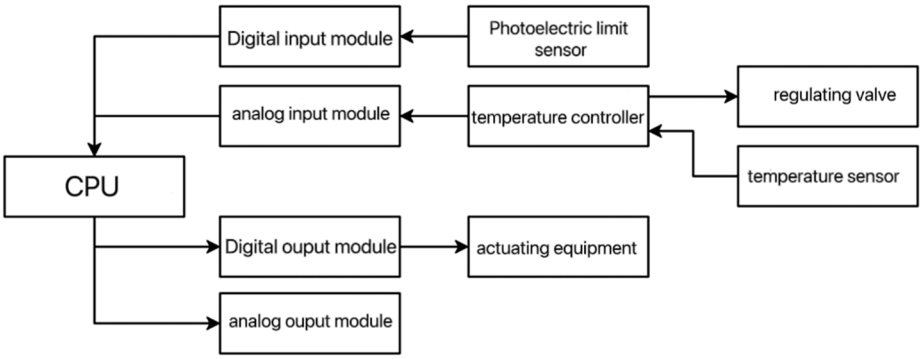


**Fig 3.** Schematic diagram of working principle of PLC control system

Specifically, the ' fruit and vegetable identification and screening camera ' sorts large and melon fruits and vegetables, and the ' fruit and vegetable identification and screening camera 2 ' focuses on rhizomes and leafy vegetables. After the first screening, fruits and vegetables are weighed into the weight sensor belt. Overweight is regarded as large fruit, which is quickly sorted by the large fruit and vegetable sorting shaft and belt. Non-overweight fruits and vegetables continue to be identified. The corresponding sorting equipment sorts fruits and vegetables, and non-fruits and vegetables go to the ' fruit and vegetable identification screening camera 2 ' for secondary identification. According to the recognition results, the system accurately controls the sorting equipment to achieve accurate sorting. This process is highly automated and intelligent, ensuring the efficiency and accuracy of fruit and vegetable processing. [5][6]

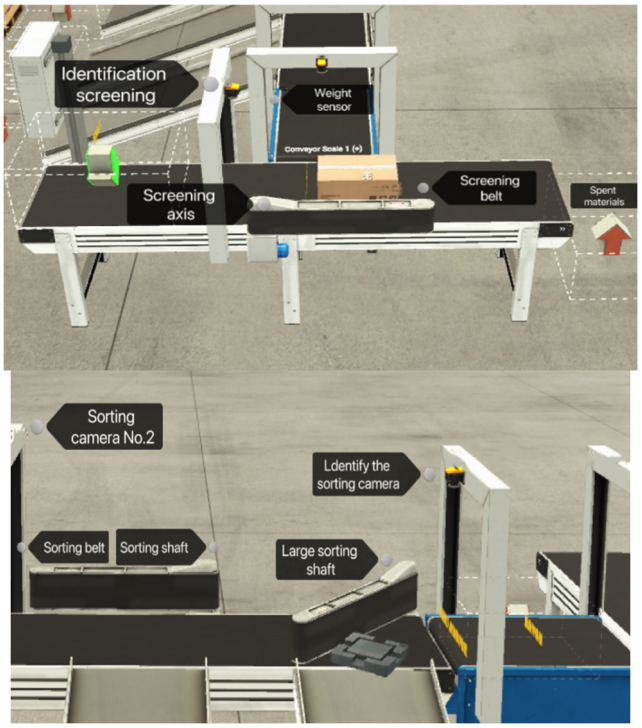


**Fig 4.** Screening process of fruits and vegetables required

## 3.2. Counting Module

Figure 5 is the counting panel of sorted fruits and vegetables. When the fruits and vegetables are sorted into the corresponding places through the sorting shaft and the sorting belt, the counter placed next to the belt counts the type of fruits and vegetables. It displays them on the counting panel of the control panel for subsequent drying. The number of fruits and vegetables is counted.

After the sorting is completed, the counter next to the belt counts the fruits and vegetables of this type and displays them on the control panel for subsequent counting during drying.

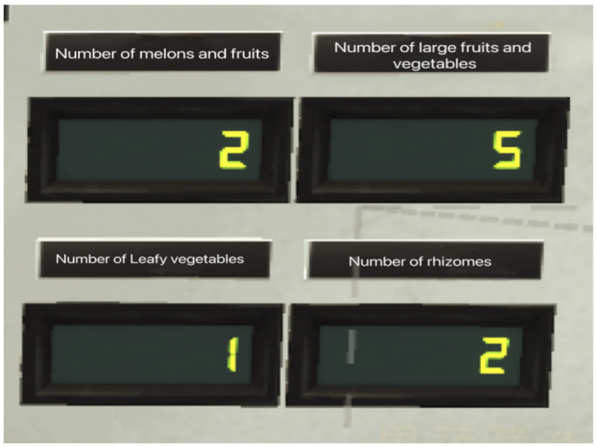


**Fig 5.** Fruit and vegetable sorting counting panel.

## 3.3. Temperature Control Module

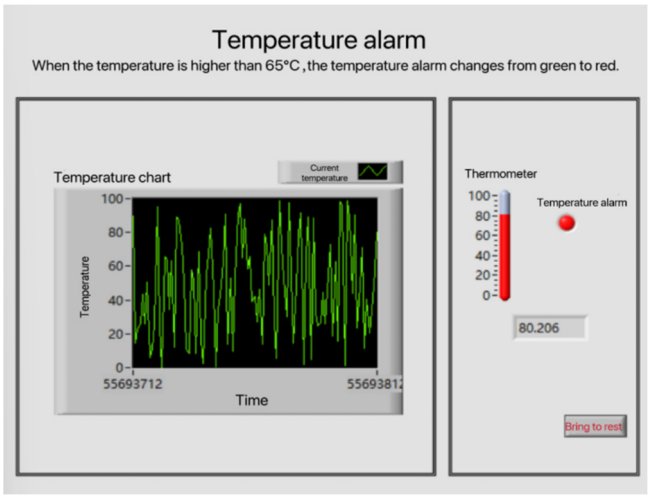


**Fig 6.** Over-temperature state

LabVIEW monitors the dryer temperature in real-time, as shown in the figure. The alarm is triggered immediately beyond the safe range to ensure the safety and controllability of the drying process. When the temperature in the dryer exceeds the preset maximum temperature of 65 °C, the temperature alarm becomes red, and the drying should be stopped immediately. After the temperature returns to normal, the next round of drying should be carried out. If the temperature is lower than 65 °C, the temperature alarm is

green. After several rounds of simulation tests, the control system successfully realized the preset drying process of pet fruits and vegetables, and all functions met the design requirements. [7-10]

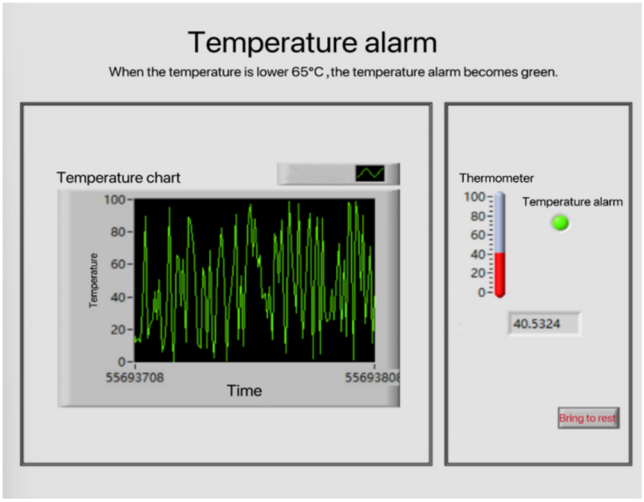


**Fig 7.** Normal state

# 4. Conclusion

This paper innovatively designs an efficient drying system for pet snacks based on PLC technology, integrates automatic control and sensing technology, realizes the automation of fruit and vegetable processing to drying, and improves food safety and convenience. S7-1200 PLC and high-precision sensing are used to ensure the integrity and safety of the process and improve efficiency. TIA-Portal V17 and LabVIEW develop the precise control program to enhance the stability of the system. The simulation verifies that it is efficient, accurate, and reliable and provides a reference for the development of pet food technology. In the future, the system will be widely used with technological progress, continuously optimized, and promote the healthy development of the industry.

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