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Design of Baijiu Intelligent Hook-up System based on Pattern Recognition

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Abstract

In order to solve the problems of unstable product quality and low production efficiency caused by human sensory influence in traditional manual blending operation, we propose to combine the theory of pattern recognition technology with Baijiu blending, and design and build Baijiu intelligent blending system based on pattern recognition. The whole system is based on the thinking of automation and data modeling technology to realize the intelligent control of Baijiu blending. Through the sensory and flavor physical and chemical data to establish the quality relationship model, the hooking and blending model; establish DIY hooking platform, joint hooking and blending to achieve the integration from order to finished product production; build hooking operation station to monitor the working status of the whole system equipment, production process and the parameters of the system instrumentation, while sharing data with the DIY information platform for production task management; PLC programmable The PLC programmable controller directly controls the field equipment and collects real-time measurement data from instruments, thus realizing a comprehensive presentation of the hooking process. After the actual test, the system has improved the network and intelligence of Baijiu hooking, and better helped the enterprise to realize quality improvement, cost reduction and efficiency increase.

Keywords

Baijiu Hooking; Automation; Data Modeling; DIY Platform; Hooking Operation Station; PLC.

1. Introduction

Baijiu industry is a traditional industry in China with a long and rich history and a unique traditional craft process. Blending, as one of the traditional brewing techniques in China, is also an emerging interdisciplinary high technology. The main purpose of blending is to make up a finished wine of a certain quality standard by skillfully proportioning the original wine of different quality and taste, so that the Baijiu quality is unified in the process of actual operation by strictly controlling the various substances in the Baijiu according to the wine design standards to blend the Baijiu with different characteristics and highlight the style of the Baijiu [1]. In current blending practice, traditional production management in the Baijiu industry uses sensory tasting for the blending and seasoning of finished wines, relying on the blender's experience and sense of smell for blending, which is

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susceptible to subjective and objective environmental factors, especially since many distilleries use outsourced wine to produce finished products, resulting in frequent changes in the physicochemical and sensory indicators of the original wine, while adding difficulty to manual blending, leading to Unstable product quality and low production efficiency. In practice, human sensory tasting experience plays a key role in blending, but this experience varies from person to person and lacks the necessary continuity, which can easily lead to "people leaving and tea going cold" [2].

The use of Baijiu blending system provides a solution to the above problem, based on chromatographic analysis, sensory tasting combined with Baijiu blending and flavoring process, to achieve intelligent control of Baijiu blending operation. since the 1980s, many scientific research institutions have carried out research on computer blending technology, and some famous Baijiu enterprises have also started to apply computer blending technology to In addition to famous breweries such as Luzhou Laojiao, Wuliangye and Guilin Sanhua, some local well-known enterprises have also started to apply it. Tai Shan Shengliyuan Group has developed a "Baijiu production CAD network system" and has put it into use [3]. The College of Engineering and Technology of Huazhong Agricultural University has introduced linear programming and objective planning in its design of computer-optimized Baijiu blending software to design an optimized recipe. In practical application it is possible to produce a least-cost recipe that satisfies the constraints (optimal taste, balanced and harmonized with various trace components). The blending process was effectively optimized based on the feature that goal planning can deal with multiple goal relationships in an integrated manner [4]. The Baijiu blending control system was applied at the Sanxia Daohuaxiang Distillery in Yichang, Hubei, to realize computer control in the Baijiu production process [5].

This paper synthesizes the current Baijiu enterprises, establishes Baijiu sensory tasting experience data model using pattern recognition and data mining in artificial intelligence technology, realizes online expert knowledge system, and establishes artificial intelligence Baijiu blending model. Combined with the current advantages of network control technology, the Baijiu blending and flavoring production process will establish an artificial intelligence blending network control system model to improve production efficiency. Based on the Baijiu database and intelligent blending system, the customer can customize the flavor through the terminal device, and the system will automatically generate orders and complete the whole process of production and canning. The PLC programmable controller layer (lower layer) is controlled by the hooking operation station (upper layer) to directly control the operation of the field equipment layer in the hooking process, and the hooking operation station (upper layer) is configured to monitor the operation status of each equipment and the system parameter data, so that the Baijiu hooking process can be carried out automatically and orderly.

2. Baijiu hooking system analysis

Baijiu uses grain cereals as the main brewing raw material, and then uses currants and distillers as saccharifying and fermenting agents [6], and achieves its unique flavor characteristics through the classic and unique production processes of steaming, saccharifying and fermentation, and distillation during the brewing process [7]. As a crucial part of the Baijiu brewing process, the blending process is an art on the tongue, focusing on the harmonious integration of the base wine and the base wine, and the subtle modification of the base wine by the flavoring wine, so as to achieve the coordination and balance of "color, aroma, taste and character", which directly determines the taste and aroma of the finished Baijiu and other important indicators [8]. The proposed blending system can significantly improve the production efficiency of the finished Baijiu and ensure the quality stability of Baijiu.

2.1 Analysis of hooking problems

To date, in most wine companies, the tradition of relying on blenders for manual blending still continues. Problems of Baijiu blending: (1) The traditional Baijiu blending technology based on manual tasting method is influenced by many subjective and objective factors and leads to large differences in individual quality. (2) The polarity and similar compatibility characteristics of trace components are not considered in small sample blending and large sample production operations, and

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although the finished product is very close to the physical and chemical index of the sample wine, the taste does not meet the production requirements. (3) Individual manufacturers use modern technology and human sensory combination to wine blending, mainly using the mathematical model of single-objective linear programming, using the simplex method to solve, and the scope of application only exists in the blending stage, due to the existence of constraints in the linear programming contradict each other and other reasons, for flavoring work due to the lack of strong mathematical theory support still can not be well applied in practice. (4) At present, some scholars propose to apply neural network technology to the hooking system, artificial neural network has the advantages of self-organization, self-learning and self-adaptation, but at the same time because for the user belongs to the "black box" operation, so the method has the limitation that the conclusions drawn by the system can not be reasonably explained to the user. This technology is still in the theoretical research stage, and no reports on the practical production of this technology have been found. (5) The blending process is closely related to the external environment such as temperature, humidity and pressure, so the feedback of the information in the mass production of large samples is not processed in real time, resulting in uneven product quality. (6) The sensory experience of blenders of some well-known enterprises cannot be preserved by scientific means, and the experience accumulated over the years cannot serve the enterprises in the long run.

2.2 General overview of the system

Baijiu intelligent hooking system mainly contains Baijiu physical and chemical indicators and sensory tasting score quality relationship model, Baijiu hooking recipe intelligent optimization model, Baijiu hooking network control model, the overall block diagram of the system is shown below.

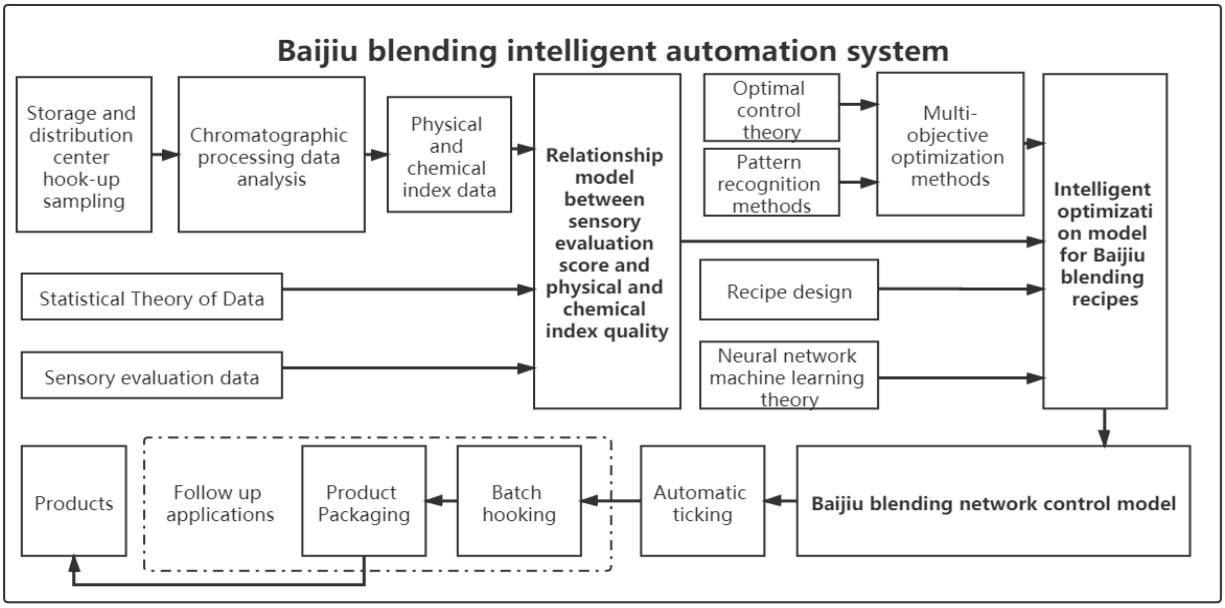

Figure 1. General block diagram of Baijiu intelligent hooking system

3. Design and implementation of Baijiu intelligent hook-up system based on pattern recognition

Pattern recognition is an important branch of artificial intelligence, mainly applied to data processing, modeling and analysis. In recent years, more and more industries are introducing AI and vigorously implementing intelligence, and so is the Baijiu industry. Due to the wide scope and many factors to be considered, most of the links are in the primary stage and have huge development space. In this paper, we propose to combine pattern recognition technology with Baijiu hooking to establish Baijiu

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intelligent hooking system, aiming to improve production efficiency and implement Baijiu intelligent automation [9].

3.1 Intelligent hooking algorithm model design implementation

In this paper, based on the data of Baijiu sensory tasting and physicochemical index testing, the quality relationship model of Baijiu sensory tasting and physicochemical indexes [10], the intelligent optimization model of hooking formula and Baijiu hooking DIY model are proposed and established by using the modeling advantages of pattern recognition technology.

3.1.1 Sensory tasting and flavor substance relationship quality model

Under conventional circumstances, the sensory tasting score of Baijiu can only rely on the tasting experience of the sommelier, which is highly subjective and inefficient, and the sommelier's palate tends to fall into fatigue, and the sensory score is volatile and unstable. The model explores the relationship between Baijiu physical and chemical indexes and sensory tasting scores, and establishes a quality relationship model by using Baijiu physical and chemical index data and sensory tasting score data. The model is trained with sample data and input unknown Baijiu physical and chemical index data to obtain the corresponding sensory tasting score. The model can replace the traditional mode of relying on human sensory evaluation scores, and can realize automatic evaluation of the sensory scores of Baijiu to be measured. At the same time, the model can also provide feedback adjustment to the recipe of Baijiu, so that the Baijiu recipe can be optimized. The structural block diagram is as follows.

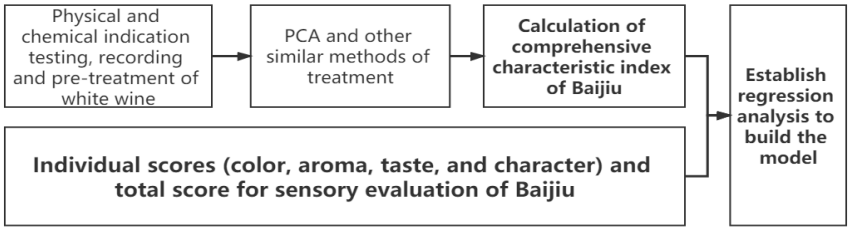

Figure 2. Baijiu sensory physical and chemical index quality relationship model block diagram

3.1.2 Checked formula model

Traditional blending recipes rely only on the blending experience of the blender and some traditional mathematical methods such as linear programming and objective programming [11, 12], and the quality of the blended wine cannot be guaranteed. This model is based on the proportional data of Baijiu blending recipes and the individual sensory tasting scores (color, aroma, taste, and character) combined with neural network technology and optimization algorithms (using GA). The specific structure of the model is shown below.

Artificial neural network breaks through the limitation of traditional serial processing of data, it is a nonlinear dynamical system and has powerful distributed storage and parallel co-processing capability. The neural network can identify the mathematical model of the object based on the input and output records of the system history, making its mathematical model and the actual object have the same input and output characteristics. Therefore, the neural network has strong nonlinear approximation ability, efficient parallel distributed processing ability and self-learning and self-adaptive ability. The data obtained by the neural network through the training of sample data can better approximate the target and further reduce the error with the target value to ensure the quality of the blended wine [13]. Neural networks, machine learning methods, in addition to satisfying the above advantages, also have certain generalization and fault tolerance capabilities, i.e., correct classification and fault tolerance in the case of redundant information in the large amount of physicochemical index data, as well as the existence of noise pollution in the model, to further ensure the stability of the taste and quality of the blended wine.

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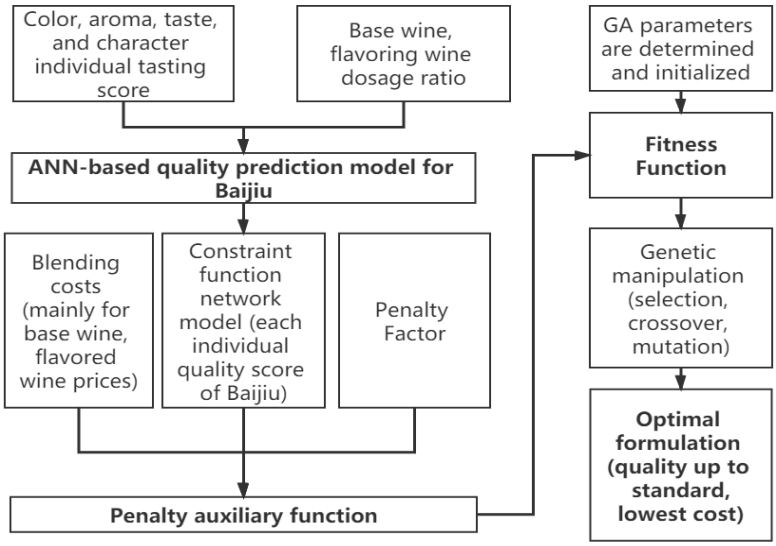

Figure 3. Block diagram of Baijiu's intelligent optimization model for check prescriptions

3.1.3 Baijiu hooking DIY platform

Baijiu DIY platform is based on Baijiu blending recipes, its back-end management built-in a variety of wine blending recipes, customers in the recipe creation area through the cell phone scan code into the customization platform, on the platform to select the recipe or according to their own needs to design their own recipes, establish the finished wine grade, packaging style, package slogans, etc., after confirming the platform automatically generated orders, and according to After confirmation, the platform automatically generates an order and automatically estimates the hook-up operation time based on the order information. After the customer pays the overall cost, the platform transmits the order information to the PLC automatic control unit, which automatically completes the operations of mixing the base wine into the wine, adding and mixing the flavored wine, and resting the wine, etc. It is then transported through the pipeline to the filling machine for filling and finally labeling and capping to complete the packaging. Customers can watch the animation process display of this blending process through the projector in the intelligent display area, and show the currently completed link, the ongoing link and the unprocessed link in the form of process nodes. The control flow of the system from receiving orders to production completion is shown in the figure below.

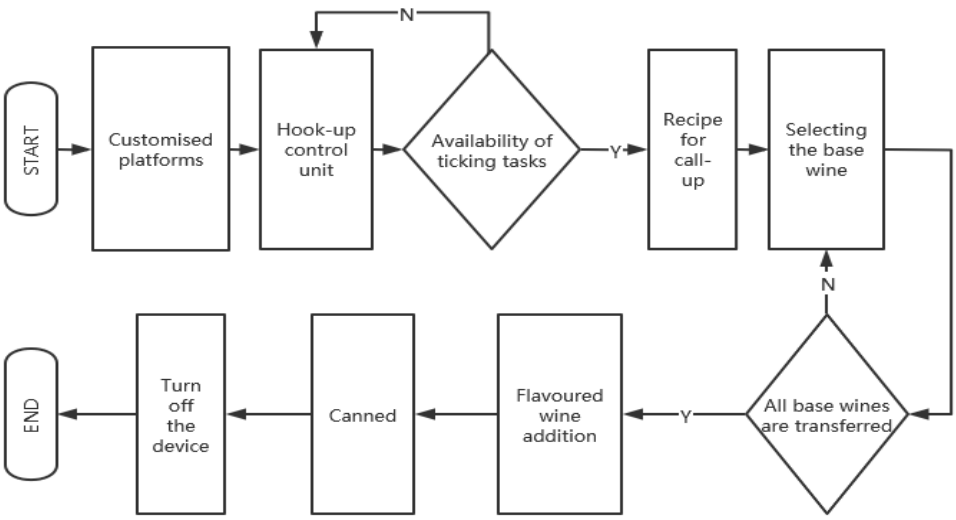

Figure 4. Baijiu hooking DIY block diagram

ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0033

3.2 PLC networked control unit design implementation

PLC as a central controller is widely used in various automation fields due to its stable performance, and the implementation of PLC networked control unit for Baijiu blending can realize fully automatic integration from original wine selection, recipe design, automatic blending, canning, and packaging, which can significantly improve the production efficiency of Baijiu, effectively control the cost and ensure the homogenization of the finished Baijiu [14].

3.2.1 Hook-up operation station (upper computer

The hooking operation itself is extremely technical, and for this reason, the hooker is a treasure in the company. The establishment of the Baijiu hooking operation station (the upper computer) is a visual representation of the hooking operation, providing a platform for human-machine interaction and improving the overall work efficiency. In addition, the operator station serves as a communication link between the hooker and the PLC controller, guaranteeing the integration of the whole system [15].

The execution data of the hook-up formula model and the hook-up operation station are connected and communicated through MySQL database, and the operation station records the user's operation data and transmits it to the PLC controller (lower computer, actuator) for automatic hook-up operation, whose specific process is shown in the figure below.

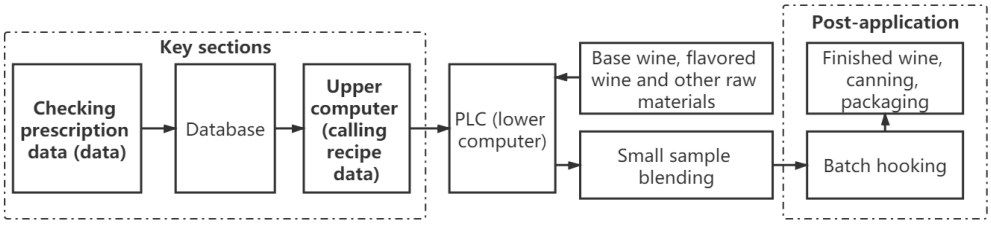

Figure 5. Flow chart of the execution of the hook-up operation station

3.2.2 PLC networked control (lower computer)

The PLC programmable controller accepts control commands from the host computer and performs data acquisition and control operations on several field devices, and collects field device data mainly for the visual display of the working status of each device and the operational progress of the whole process[16, 17].

The networked control of Baijiu hook-up is a relatively complex process, which needs to be controlled by more devices, mainly electric control valves, flow meters, liquid level transmitters, solenoid valves, transfer pumps and temperature transmitters, etc. Since the object of control operation is Baijiu (flammable and explosive products, food), the overall design and construction needs to be carried out under the guidelines of hygiene and explosion-proof. The control execution flow chart of the PLC networked control unit (lower unit) is shown in the figure below.

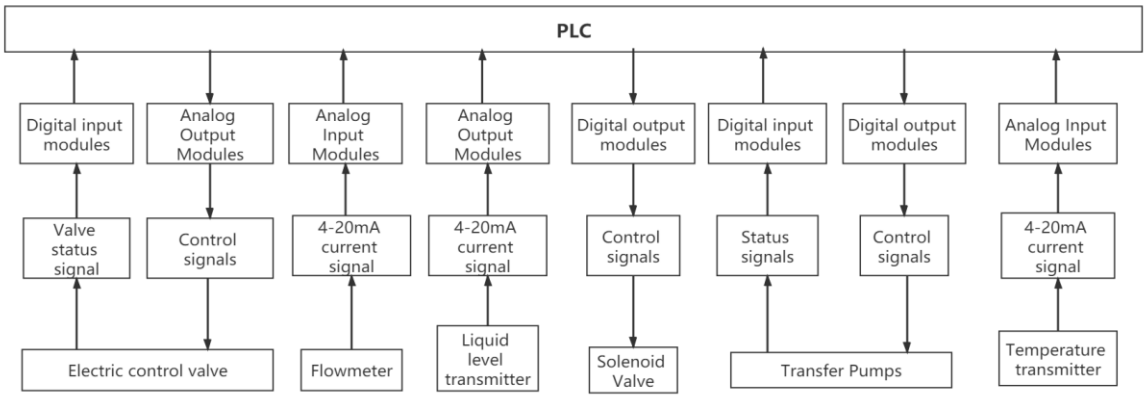

Figure 6. PLC controller execution flow chart

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4. Baijiu intelligent hooking system application analysis

The pattern recognition-based Baijiu intelligent blending system designed and built in this paper has been used in a preliminary experimental application in a liquor company. The applicability and generalization of the whole system are discussed from the system validation analysis, and the advantages and shortcomings of the system are analyzed from the application effect level.

4.1 System Validation Analysis

After the field experiment of the system and the comparison of the traditional manual operation results, it is clear that the idea of combining pattern recognition technology, PLC automatic control technology and Baijiu blending operation to improve the production efficiency and stabilize the quality of liquor is correct and feasible. The quality model of the relationship between sensory evaluation and flavor substances can effectively reflect the complex relationship between sensory and flavor content, reduce the magnitude of human sensory fluctuations, and provide a data base for the establishment of the blending recipe; the Baijiu blending recipe model based on sensory and flavor physicochemical data can realize the rapid design of blending recipes, improve work efficiency, and reduce the degree of human subjective influence; Baijiu The proposal and construction of the Baijiu blending DIY platform has completed the fully automated integration from receiving Baijiu orders to producing finished wine, with users placing orders on demand and enterprises producing according to standards, greatly simplifying the traditional order receiving mode; in the PLC network control unit part, the PLC controller reads recipe information to achieve accurate control of equipment devices, changing the traditional blending operation that relies on manual completion. mode.

4.2 Application effect analysis

After on-site experimental feedback and combined with the use of the hooker shows that: (1) effective visualization of Baijiu hooking operation; (2) convenient management of hooking equipment and raw materials; (3) significantly reduces the traditional hooking manual participation time and improves Baijiu production efficiency; (4) to a certain extent control the cost of Baijiu production, detailed comparisons are shown in the table below.

Table 1. Effectiveness analysis table

System Usage	Staffing (Number of people)	Average working (hours)	Cost of ticking (million yuan)
Traditional blending	5	1	2
Use this system to hook up	2	0.5	1.9
Contrast Analysis	↓60%	↓50%	↓5%

(Take the hookup 1t low-grade strong Baijiu as an example)

From the above analysis, the use of the hooking system makes the whole hooking operation in terms of staffing, working hours and hooking costs compared to the traditional manual hooking has a significant improvement.

5. Summary and outlook

The proposed construction of Baijiu intelligent hooking system based on pattern recognition is mainly realized through the combination of data modeling and PLC automatic control. The quality relationship model based on sensory data and flavor substance data, the hooking recipe model and the proposed DIY platform for hooking are the presentation of Baijiu hooking data and intelligence; the PLC network control unit is the embodiment of hooking automation. The use of the hooking system is very advantageous in terms of production efficiency and cost control compared to traditional hooking operations. However, the system has no way to completely replace the manual, only a form of assistance to participate; the accuracy and reliability of the system can not reach the quality management requirements of the middle and high-end Baijiu, only applied to some low-end Baijiu production.

With the continuous expansion of the basic data, the more obvious the perceived advantages of pattern recognition technology, the stronger the accuracy and reliability of the model, and the more intelligent the whole system is, which can meet the requirements of the hooking operation of most products in the wine enterprises. The Baijiu intelligent blending system based on pattern recognition proposed in the paper is an exploratory study combining the field of Baijiu with artificial intelligence technology, and provides a reference for promoting Baijiu intelligent automated production to practitioners' deeper research.

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