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Retraction

Retracted: Design and Simulation Analysis of a Flexible Clamping and Conveying Device of a Green Leafy Vegetable Cutting and Bundling Integrated Machine

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] Z. Wang, T. Yang, and W. Wei, "Design and Simulation Analysis of a Flexible Clamping and Conveying Device of a Green Leafy Vegetable Cutting and Bundling Integrated Machine," *Journal of Robotics*, vol. 2022, Article ID 4729480, 9 pages, 2022.

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Research Article

Design and Simulation Analysis of a Flexible Clamping and Conveying Device of a Green Leafy Vegetable Cutting and Bundling Integrated Machine

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In order to improve the harvesting production efficiency of green leafy vegetables, this paper designs and simulates the flexible clamping and conveying device of the green leafy vegetable cutting and bundling integrated machine. Through theoretical calculation and 3D modeling, the design optimization of key components is carried out in this paper. The cutter head of the guillotine cutting and throwing device is a wheel cutter type. The throwing blades are axially symmetrically distributed on the cutter head, and the movable blades are radially distributed at equal angles and are located in the middle of the two throwing blades. The electronic control system of the wrapping device uses a pressure sensor to cooperate with the baling device to realize automatic wrapping after baling. In addition, the drive chassis of the machine is a hydrostatic drive system, which is convenient for step-less speed change and automatic control within a certain range. Through the simulation study, it can be seen that the flexible clamping and conveying device of the green leafy vegetable cutting and bundling integrated machine proposed in this paper can meet the industrialization needs of green leafy vegetables.

1. Introduction

At present, the domestic method of bundling vegetables is mostly carried out manually, which has low work efficiency, high labor intensity, and high-cost consumption. In order to make up for the lack of single technology of traditional vegetable harvesters, a baling device is installed on the basis of traditional vegetable harvesters so that the whole machine can integrate the functions of harvesting and bundling. At the same time, according to the development trend of mechatronics technology, modern sensor detection technology, lithium battery management technology, and advanced mechanical design and manufacturing technology are used to innovate and optimize the structure of traditional vegetable harvesters.

With the continuous improvement of product functions of vegetable harvesters, consumers are no longer limited to traditional industrial design with their functionality as market-oriented products but increasingly pay attention to the actual user experience and visual experience of their products. This brings challenges to the design work of the harvester product. In other words, today's consumer demand structure has shifted from a functional focus to a spiritual focus. In view of this, the appearance design of the vegetable harvester is particularly important. The solution is to replace manual labor with more mechanized operations, so as to improve the production efficiency of the enterprise as much as possible and achieve the goal of liberating labor [1]. The product design of a vegetable harvester is complex and changeable work. In the whole process of product design, it is necessary to fully consider many influencing factors such as the requirements of users in the actual application scenario and the limitations of the environment used. Whether the product design of the vegetable harvester is successful or not requires us to test it in practical application scenarios. Therefore, in the design process of vegetable harvester series products, we need to analyze these relevant situations and methods, find the key points of the design, and then carry out the design work to make it more reasonably suitable for its future practical application [2].

The concept of context first appeared in the field of social psychological science. It has different names and can be called context, background, etc. In the field of design, the concept of context is widely used. The practical point of view has made a rich substantive inquiry. In terms of considering multiple factors, theoretical analysis and experiments, literature [3] obtained second-order differential equations about blade weight, knife thickness, cutting speed, friction factor, straw section size, and other factors through theoretical analysis and derivation, and conducted cutting tests on vegetables using the designed cutting test bench to verify the accuracy of the equation analysis results, and obtained the influence of parameters in the equation on cutting power consumption. Literature [4] designed a lettuce harvester, which uses batteries to provide cutting and transportation power. The cutting device is a double action knife, which can perform reciprocating cutting. This model is characterized by the design and use of an electric push rod to achieve the movement of the cutting device and ensure the harvest height of different vegetables. Literature [5] has designed and completed a stubble cutting grassland harvester, which is self-propelled and can meet the needs of weeds. The problems pointed out in the paper have guiding significance for the design of harvesting machinery. Literature [6] has developed a vegetable harvesting, sowing and transplanting machine. Through parallel control of the hydraulic landing gear and the micro adjustment device, the position of the cutter and the collecting device can be adjusted to ensure that the stubble height of the leafy vegetables after cutting is consistent, so that the machine can harvest on the flat and ridge at the same time, and improve the versatility of mechanical harvesting. Literature [7] designed a vegetable sowing and harvesting combined machine. The machine adopts a walking operation and a chain cutter. The cutter is a sickle shaped machine. The cutting device is operated by turning wheels and combining gear and chain drive.

Literature [8] proposed the research and development of a small leafy vegetable harvester, mainly for golden cauliflower and bean sprouts. The use of a high-voltage battery drive mode can provide a continuous power supply, which can easily complete the planting, production, harvesting, and transportation of various vegetables, and can ensure that the machine can move or turn freely in the field. Although the tools used for the cultivation and harvesting of these kinds of crops have been able to improve the production efficiency by dozens of times, for the cultivation ground of agronomic plants with poor flatness, the mechanization height of the tools used for harvesting has not yet fully met the relevant national regulations [9]. The authors in [10] designed a small multifunctional machine suitable for harvesting water cabbage grown in South China. In this design, only theoretical calculations are involved, and a prototype has not been manufactured and verified in the field. The working efficiency of this machine is also worthy of consideration. Although some progress has been made in mechanization and harvesting technologies for vegetables and agricultural products, the pace of development has been slower. The main reason for this is that agricultural production and planting environments are differentiated. As far as the same green leafy vegetable is concerned, there are also large gaps in terms of land leveling and planting density under different regional planting environments [11]. Harvesting machines currently manufactured are not suitable for the adjustment of objective differences between the above two. According to relevant statistical results, there are as many as 30 kinds of green leafy vegetables grown. Different vegetable varieties utilize different harvesting techniques and requirements. For market demand, cilantro and spinach require rhizomes to be retained; Chinese cabbage requires rhizomes to be removed. Therefore, a vegetable harvester with high compatibility features has a long way to go in its design and manufacture [12]. In the process of mechanized picking of green leafy vegetables, if there are problems such as improper handling, it is easy to cause serious damage to the appearance of agricultural products, which will be further aggravated in the subsequent recovery, transportation, and sales process [13]. In the vegetable market, the sales appearance of vegetables has always been an important indicator that consumers are very concerned about. Any damage to the appearance will directly lead to a plummeting vegetable price, which has become a difficult point in the design of leafy green vegetable harvesting machinery [14].

The working process of the cutter and baler is to cut stalks and then bundle them. The bundles need to be laid out in an orderly manner. Therefore, the designed cutter and baler must meet many conditions. According to the harvesting experience, the following points can be summarized: (1) In order to adapt to the complexity of the terrain, the baler needs to have a good ability to walk on the ground; (2) the harvesting effect does not change due to the height of the stalk, allowing crops to have a difference in the height of the stalk; (3) for lodging stems, normal harvesting can be achieved without missing cuts [15]; (4) the harvesting effect does not change due to the maturity or yield of crops; (5) the knotted rope ends should be moderately tight and should be transported and sun-dried in bundles; (6) for different stem crops, specific agronomy should be considered [16]. According to the complex structure and design conditions of the cutter and baler, the operation overview of the existing cutter and baler is introduced: in the preprocessing device of the cutter and baler, after the stalks are separated by using the crop divider, the reel star wheel cooperates with the helper board. The stalks to be cut are sent to the cutting area. When the cutter cuts the stalks, the front-end processing device plays a supporting role. After cutting, the stalks are discharged to the baling mechanism through the conveyor belt on one side [17]. When bundling, due to the action of the pressing rod, the stalk is transported between the harvesting platform and the rope guide plate, and the clutch control rod prevents it from coming out. At this time, the baling needle makes a rotary motion and wraps the rope around the stalk, and the knotting nozzle ties the rope at the top of the baling needle to the other rope end on the rope pressing plate and is acted by the release rod to release the rope. When the bale is pushed out of the bale frame, the bale rope is cut off, and finally, the clutch is reset to complete one bale [18].

This paper designs and simulates the flexible clamping and conveying device of the green leafy vegetable cutting and bundling integrated machine to improve the working efficiency of the green leafy vegetable cutting and bundling machine.

2. Structural Design

2.1. Working Principle. When the machine is working in the field, green leafy vegetables are supported by the grass-supporting device on the integrated header and then divided by using the grass-dividing fork. Then, green leafy vegetable straws are cut by using the saw disc and the conveying drum, and the cut green leafy vegetable straws are forcibly fed through the feeding mechanism of the header and transported to the material chopping and throwing device. After that, the green leafy vegetable straws are cut and thrown, and then, the crushed green leafy vegetable straws are thrown into the bin of the baling device through the throwing tube. Then, the crushed green leafy vegetable straws are fed into the baling chamber from the forage feeding mechanism below the silo in an orderly manner for baling operation. After the baling device bales broken straws into dense round bales, the hydraulic cylinder controls the opening of the bin door of the baling device to transport the round bales to the coating device for coating operation. The coating device starts to work under the control of the hydraulic system. With the cooperation of the wrapping rotating mechanism of the wrapping device and the rolling frame, round straw bales are evenly wrapped. When the round straw bales are wrapped, the unloading guide of the wrapping device is opened, and the round bale slides down to the ground along the unloading guide. Then, the unloading bale guide is recovered and restored to prepare for the next operation. Finally, the round straw bales can be stored and transported or packaged and directly ensiled on the field. The flowchart of the machine operation is shown in Figure 1.

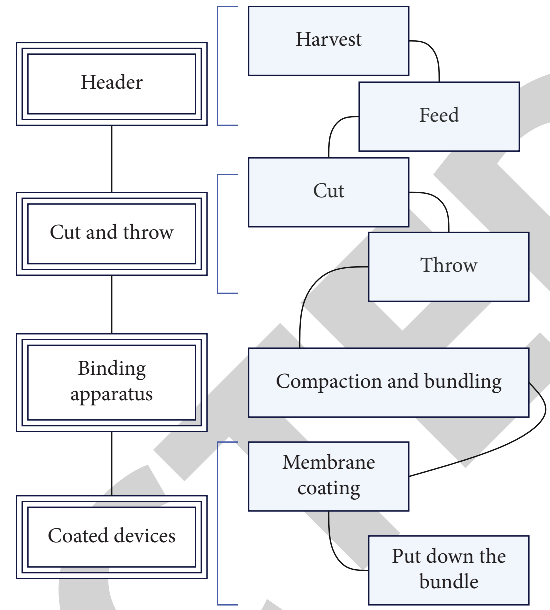


Figure 1: Flowchart of the whole machine operation.

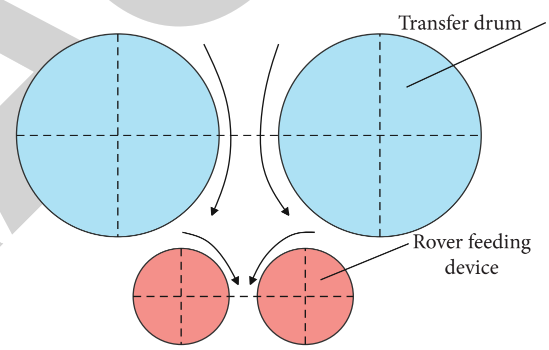


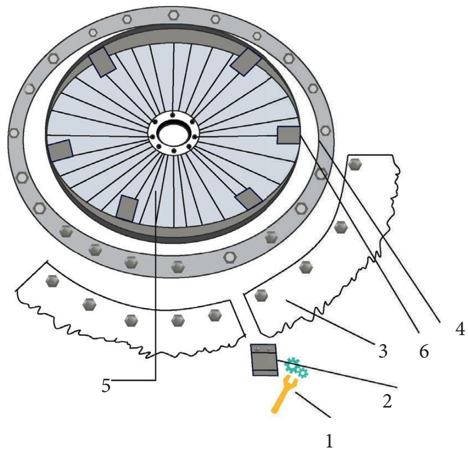
Figure 2: Schematic diagram of the transmission route.

2.2. Design of Key Components for Green Leafy Vegetable Harvesting. The integrated header suspension mechanism of the green leafy vegetable harvesting, baling, and wrapping machine adopts a four-bar linkage mechanism, and a four-bar linkage mechanism consisting of an upper connecting rod and two lower connecting rods is mounted on the chassis. Two lifting cylinders play a supporting role, which can control the header to rise and fall within a certain range (lifting range 0~715 mm). The four-bar linkage is equipped with a safety-locking device, which can be locked during transportation or maintenance under the header, which can protect the hydraulic system of the header and the personal safety of the driver. The main working mechanism of the header is two header-conveying rollers, and a saw disc is installed at the lower part of each conveying roller. When the green leafy vegetable harvester is working, green leafy vegetables are fed by using the weeding device. Then, it is divided into the conveying drum using the crop divider and the crop fork, green leafy vegetables are cut by using the saw disc, and the whole corn is transported to the rolling feeding device by using five-level shifting teeth I–V. It is forcibly fed from the rolling feeding device to the material cutting and throwing device. The material cutting and throwing device chops and throws green leafy vegetables, and the broken straw is guided by using the throwing cylinder and transported to the silo of the baling device. Figure 2 shows a schematic diagram of the transmission route of the conveying drum and the rolling feeding device of the green leafy vegetable harvester header.

The V-belt is selected for speed regulation, and the diameters of the driving pulley and the driven pulley (conveying roller pulley) are designed to be $d_1 = 118$mm and $d_2 = 1090$mm, respectively. n_1 and n_2 are the rotational speeds of the main and driven pulleys, respectively, and then, the speeds of the two pulleys are as follows:

$$v_1 = \frac{\pi d_1 n_1}{60 \times 1000},$$
$$v_2 = \frac{\pi d_2 n_2}{60 \times 1000}. \quad (1)$$

In the formula, v_1 is the peripheral speed of the driving pulley, m/s; v_2 is the peripheral speed of the driven pulley, m/s; d_1 is the diameter of the driving pulley, mm; d_2 is the



1. Fixed bolt 2. Cleaner 3. Blade 4. Blade fixed holder 5. Cone 6. Reinforcement plate

Figure 3: Exploded view of the saw disc.

diameter of the driven pulley, mm; n_1 is the rotational speed of the driving pulley, r/min; and n_2 is the rotational speed of the driven pulley, r/min.

Since the slip rate of the V-belt drive is very small, it can be ignored in the general calculation, and the transmission ratio of the belt drive is obtained as follows:

$$i_1 = \frac{n_1}{n_2} = \frac{d_2}{d_1}. \tag{2}$$

The rotational speed of the driven pulley is obtained by the following formula:

$$n_2 = \frac{n_1 d_1}{d_2}. \tag{3}$$

The speed n_2 of the driven pulley is calculated to be $1010r$/min.

Then, the main reducer is used for deceleration, the double output shaft reducer is selected, and its transmission ratio i_2 is 2.5; then, the speed n_3 of the output shaft is as follows:

$$n_2 = \frac{n_3}{i_2}. \tag{4}$$

The rotational speed n_3 of the output shaft calculated by formula (4) is $2525r$/min.

The saw disc of the integrated header is composed of fixing bolts, cleaners, blades, blade-fixing seats, cones, and reinforcing plates. The saw disc is installed under the conveying drum to neatly saw off the green leafy vegetables to be harvested. The blade inertia force of this cutting method is easy to balance, the vibration is small, and the structure is simple. Figure 3 shows an exploded view of the saw disc.

In order to ensure that the conveying roller can keep working normally, there are certain position requirements between the comb-tooth plate and the conveying roller. Figure 4 shows a schematic diagram of the positional relationship between the comb-tooth plate and the conveying roller.

During the vertical lift process, the crushed straw with mass m is thrown by using the throwing blade at the initial velocity of V_1. The throwing speed is V_2 (in order to make the broken straw leave the pipe neatly, there should be $2 \sim 3m/s$), so it takes $V_2 = 2 \sim 3m/s$. According to the law of conservation of energy, we can get

$$\frac{1}{2}mV_1^2 = mgH + \frac{1}{2}mV_2^2. \tag{5}$$

Considering the lost energy, we get

$$\frac{1}{2}mV_1^2 = mgH\left(1+\mu_1\right) + \frac{1}{2}mV_2^2. \tag{6}$$

In the formula, V_1 is the initial velocity of the shredded straw thrown, m/s; V_2 is the final speed at the exit, m/s; and μ_1 is the energy loss coefficient of friction loss with the pipe wall and the loss of materials colliding with each other and the resistance of the air in the pipe during the lifting process. It is often taken as $\mu_1 = 0.22$.

The initial speed at which the broken straw is thrown is as follows:

$$V_1 = \sqrt{2gH\left(1+\mu_1\right) + V_2^2}. \tag{7}$$

Combined with formula (7), considering the speed loss of the throwing blade on the cutter head when it hits the straw, the actual speed of the throwing blade during the vertical lift should be

$$V_{\text{Ò¶}} = \left(1+\mu_2\right)V_1 = \left(1+\mu_2\right)\sqrt{2gH\left(1+\mu_1\right) + V_2^2}. \tag{8}$$

In the formula, V_1 is the initial velocity of the shredded straw, m/s; V_{leaf} is the actual speed of the throwing blade, m/s; and μ_2 is the difference loss coefficient between the peripheral speed of the thrown blade and the initial speed V_1 of the broken straw (it is often taken as $\mu_2 = 0.55$).

According to formula (8), the rotational speed required to throw the blade is as follows:

$$n = \frac{30V_{leaf}}{\pi R} = \frac{30}{\pi R}\left(1+\mu_2\right)\sqrt{2gH\left(1+\mu_1\right) + V_2^2}. \tag{9}$$

In the formula, H is the lift height (height of the model), m; R is the inner diameter of the blade taken (the most unfavorable when throwing at this point), m.

Since the designed throwing device is not a vertical lift but has a certain inclination $\alpha = 73^\circ$, at this time, the initial velocity of throwing is no longer V_1, but we obtain the following equation:

$$V_1' = V_1 \sin\alpha. \tag{10}$$

Therefore, we get

$$V_1 = \frac{V_1'}{\sin\alpha}. \tag{11}$$

Combined with formula (8), the actual speed of the throwing blade is as follows:

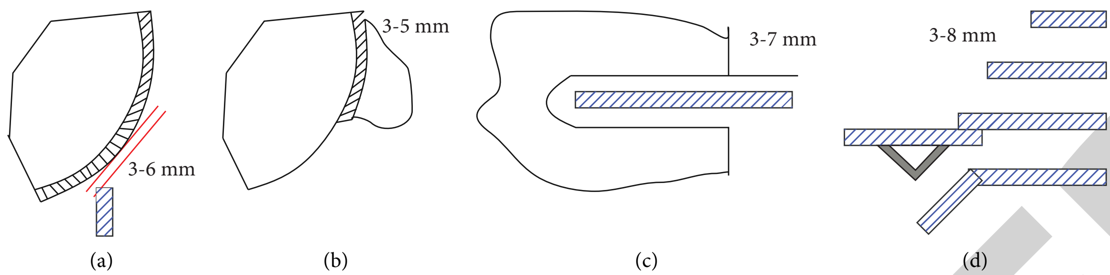


Figure 4: Schematic diagram of the positional relationship between the comb plate and the conveying roller: (a) clearance between the conveying roller and the vertical plate, (b) clearance between the delivery roller and the transverse comb plate, (c) space between the transport roller flange and the comb-tooth plate groove, and (d) clearance between the transport roller flange and the middle separator.

$$V_{leaf} = \frac{(1+\mu_2)}{\sin\alpha}\sqrt{2gH(1+\mu_1)+V_2^2}. \quad (12)$$

Combined with formula (9), the rotational speed of the throwing blade in the design model is obtained at least as follows:

$$n = \frac{30V_{leaf}}{\pi R} = \frac{30}{\pi R}\,\frac{(1+\mu_2)}{\sin\,\alpha}\sqrt{2gH(1+\mu_1)+V_2^2}. \quad (13)$$

According to formula (13), the rotational speed $n = 800r/\mathrm{min}$ of the throwing blade of the guillotine cutting and throwing device is obtained; that is, it is determined that the rotational speed of the cutter head shall not be lower than $800r/\mathrm{min}$.

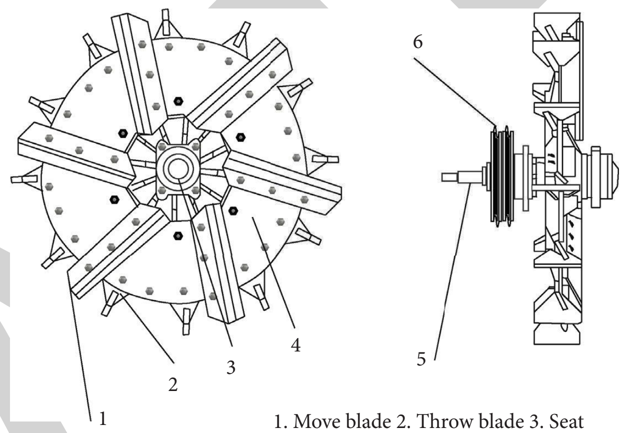
The cutter head is the main working mechanism of the guillotine cutting and throwing device, and its structure is a wheel cutter type, which is composed of a cutter wheel, a fixed blade, and a cutter wheel box. The rolling feeding device squeezes corn stalks and feeds them to the entrance of the cutter wheel box forcibly. Under the support of the fixed blade installed at the entrance of the cutter wheel box, the straw is slid and cut into pieces by a high-speed rotating moving blade, and the cutting process is completed. The throwing piece is welded on the edge of the cutter wheel, which has achieved the purpose of throwing. This design method has the advantages of simple structure, convenient installation, and use and can meet the above requirements for cutting stalks of different lengths and consume less power. Figure 5 shows a schematic diagram of the structure of the material shredding and throwing device.

The gap between the movable and fixed blades of the guillotine-cutting and throwing device and the sharpness of the cutting edge directly affect the cutting quality of green leafy vegetable straws and the power consumption of the machine. In order to ensure the cutting quality of straws and reduce the loss of power, the gap between the movable and fixed knives is 0.5~1 mm.

Unbalanced masses in rotational motion cause inertial forces, which can be expressed as follows:

$$P_B = -\left(m+\frac{1}{2}M_L\right)r\omega^2. \quad (14)$$

In the formula, P_B is the inertial force caused by an unbalanced mass in rotary motion, N; m is the mass of the



1. Move blade 2. Throw blade 3. Seat bearing 4. Knife plate 5. Main shaft 6. Pulley

Figure 5: Cutter assembly diagram.

crank pin, g; M_L is the mass of the connecting rod (1/2 of M_L makes a rotary motion on the crank pin, and 1/2 makes a reciprocating motion on the cutter), g; r is the radius of gyration, mm; and ω is the rotational angular velocity, rad/s.

In general, a balance weight mounted on the crank disc can balance all the rotational inertia force P_B and part of the reciprocating inertia force P_A (1/3 ~ 1/2) to determine the quality of the weight can be expressed as follows:

$$P_P = P_B + \frac{1}{2}P_{A\max} = \left(m+\frac{1}{2}M_L\right)r\omega^2 + \frac{1}{2}\left(M_H+\frac{1}{2}M_L\right)r\omega^2,$$
$$P_A = -\left(M_H+\frac{1}{2}M_L\right)r\omega^2\cos\omega t,$$
$$P_{A\max} = -\left(M_H+\frac{1}{2}M_L\right)r\omega^2. \quad (15)$$

In the formula, P_P is the weight of the counterweight, N; P_A is the inertial force caused by the unbalanced mass in reciprocating motion, N; $P_{A\max}$ is the maximum inertial force of part of the reciprocating motion, N; and M_H is the mass of the cutter, g.

After calculating the mass P_P of the counterweight, the weight of the counterweight and the radius of the counterweight can be calculated according to the following formula:

$$P_P = m_P r_p \omega^2. \quad (16)$$

In the formula, m_P is the weight of the balance block, N; r_P is the radius of the balance block, mm.

If any one of m_P, r_P is selected, another parameter can be obtained. Here, the radius $r_P = 8\text{mm}$ is taken to obtain the mass $m_p = 25g$ of the counterweight.

2.3. Design of the Main Components of the Baling Device. The baling device can perform fixed work and pulling work. During fixed operation, the baling device is placed on flat ground, and the frame is adjusted to make the baling device in a horizontal state. Then, the shredded straw is directly fed into the silo to complete the baling operation. During towing operation, the baler is placed on the chassis of the silage-integrated machine, and the power input shaft of the baling device is connected to the hydraulic motor of the integrated machine so that the control of the baling device can be completed in the cab. Figure 6 shows a flowchart of the operation of the baling device.

The control system of the coating device is composed of a pressure-sensing module, signal detection module, optocoupler, single chip AT90CAN64, drive module, control relay, A/D conversion, and display module.

The signal detection module is connected to the optocoupler, the optocoupler and the pressure- sensing module are connected to the single-chip microcomputer, the single-chip microcomputer is connected to the driving module and the A/D conversion module, and the driving module is connected to the control relay. The signal detection module collects the signal, and the signal is transmitted to single chip AT90CAN64 through the optocoupler, and the single chip processes the received signal. Then, the drive module sends a command signal to the control relay to respond, and the control relay controls the solenoid valve to change the start and stop of the oil circuit and the engine. The system uses the pressure sensor to cooperate with the baling device to achieve automatic wrapping after baling. Figure 7 shows a schematic diagram of the control system.

The film has extremely high elasticity, which can reach 70% of the tensile strength in the working state, and high elasticity can improve the wrapping degree of straw bales. Moreover, the purpose of saving the film can be achieved, and the film has good adhesion properties so that the wrapping effect cannot be affected by the external temperature.

The hydrostatic drive system of the drive chassis of the green leafy vegetable harvesting, baling, and wrapping machine is composed of the high-pressure closed quantitative motor, reduction mechanism, mechanical gearbox, walking front wheel, hydraulic oil pipe, fuel tank, radiator, high-pressure closed variable displacement plunger pump, and high-pressure plunger pump oil port. The hydrostatic drive has a series of advantages such as high stability, fast response speed, and good control performance, which facilitates the realization of the functions of continuously variable speed change and automatic control within a certain range. The schematic diagram of the hydrostatic drive system is shown in Figure 8.

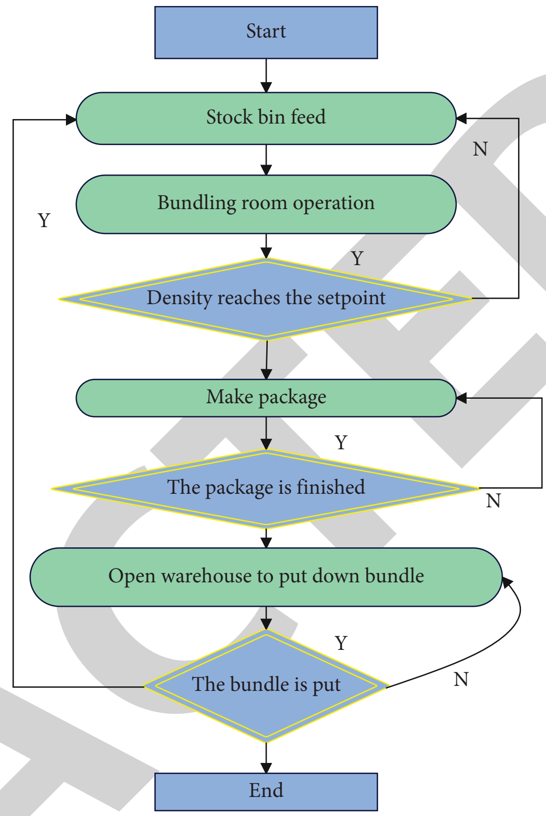


Figure 6: Operation flowchart of the baling device.

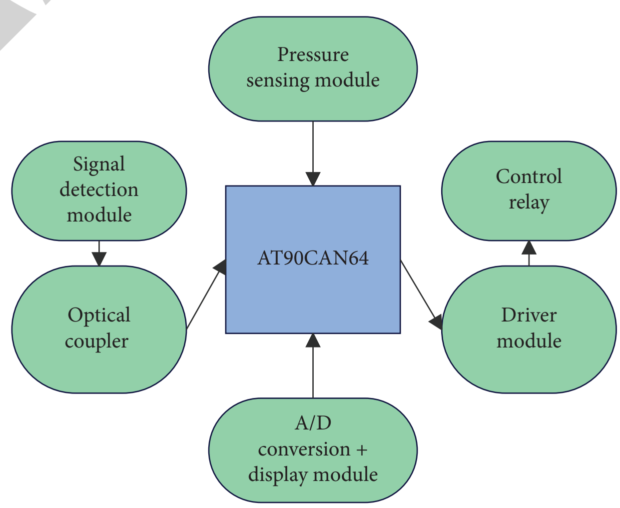
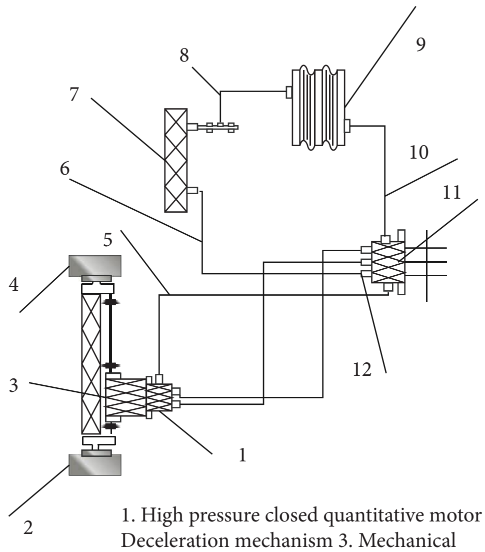


Figure 7: Schematic diagram of the control system of the coating device.

A hydraulic pump provides liquid with certain pressure and flow to the system and converts mechanical energy into pressure energy of liquid. Hydraulic pumps are divided into gear pumps, plunger pumps, vane pumps, and screw pumps according to the shape and movement mode of the main moving components and can be divided into variable pumps and quantitative pumps according to whether the flow can



1. High pressure closed quantitative motor 2. Deceleration mechanism 3. Mechanical transmission 4. Walking front wheel 5. I hydraulic pipe 6. Hydraulic pipe 7. Tank 8. Hydraulic pipe 9. Radiator 10. IV hydraulic pipe 11. High pressure closed variable plunger pump 12. High pressure plunger pump port

Figure 8: Schematic diagram of the hydrostatic drive system of the drive chassis.

be adjusted. Moreover, a diesel engine with a rated speed of 3000 r/min was selected as the power source, and a dual-pump dual-motor drive scheme was adopted in consideration for economic needs.

The formula for calculating the maximum displacement of the hydraulic pump is as follows:

$$q_{p\max} \leq \frac{q_{m\min} n_{\max} z}{0.95^2 n_{ph}}. \quad (17)$$

In the formula, $q_{p\max}$ is the maximum displacement of the hydraulic pump, cm^3/r; $q_{m\min}$ is the low displacement of the drive motor, cm^3/r; z is the number of drive motors; and n_{ph} is the engine speed, r/min.

Through calculation, we can get $q_{p\max} \geq 50.11 cm^3/r$, and finally, we choose a Linde Hydraulics HPV-02 series closed-circuit hydraulic pump with displacement $54.7 cm^3/r$.

The high-pressure closed-type quantitative motor, gearbox, and reduction mechanism can control the walking speed of the front wheel of the integrated machine in the field. The radiator is installed above the motor to dissipate heat and keep the machine running normally. The high-pressure closed variable displacement piston pump adjusts pressure, flow, and direction by controlling the pressure of the pilot oil, which reduces the control of the electrical proportion. Therefore, it has simple and convenient operability and safe and reliable usability.

The central electronic control and detection monitoring system of the whole machine mainly relies on the onboard monitoring device. It is mainly composed of five submodules, namely, the overall vehicle controller, the integrated instrument cluster module, the intelligent alarm system, the video processing system, and the working

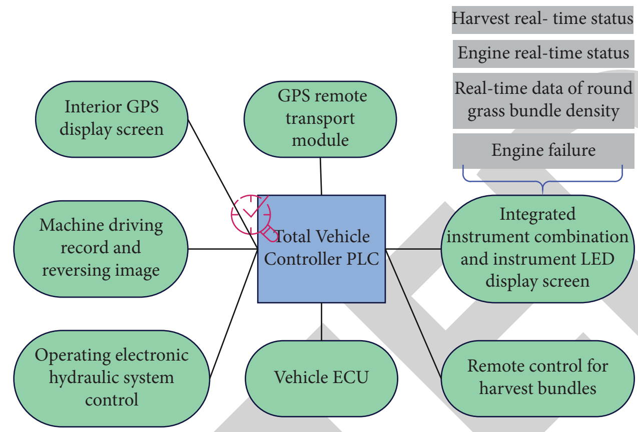


Figure 9: Architecture diagram of the central electronic control and detection and monitoring system of the whole machine.

electronic hydraulic control system module. The general controller of the whole vehicle monitors the working conditions of the key components of the whole machine at any time through the output terminal and displays the running data of the whole vehicle on the LCD screen. The architecture diagram of the central electronic control and detection and monitoring system of the whole machine is shown in Figure 9.

3. System Simulation

The driving force is set to 360 d*time, which means that the crank makes one revolution per second, and the feasibility of the model is verified. The simulation analysis time is set to 2 s, and the analysis step size is 200. By clicking the simulation button to get the animation verification, Figure 10(a) shows the change in the speed and acceleration of the baling needle. It can be seen that the baling needle rotates first before bundling, and then the speed changes suddenly, and the speed is zero at the instant of baling. The maximum change in the acceleration of the baling needle in the figure is about 3500 mm/s. Figure 10(b) shows the changes in angular velocity and angular acceleration of the baling needle. It can be seen that the variation of angular velocity is similar to the variation of velocity, and the variation range of angular acceleration is also relatively large, so the selection of materials and processing requirements are relatively high during physical manufacturing. Figure 10(c) shows the force change diagram of the baling needle, and the variation range is small. In conclusion, the virtual design size of the baling needle frame is reasonable and can be used as a reference for subsequent prototype processing.

Through the above simulation research, it can be seen that the flexible clamping and conveying device of the green leafy vegetable cutting and bundling integrated machine proposed in this paper can meet the industrialization needs of green leafy vegetables and can effectively improve the production efficiency in the harvesting of green leafy vegetables.

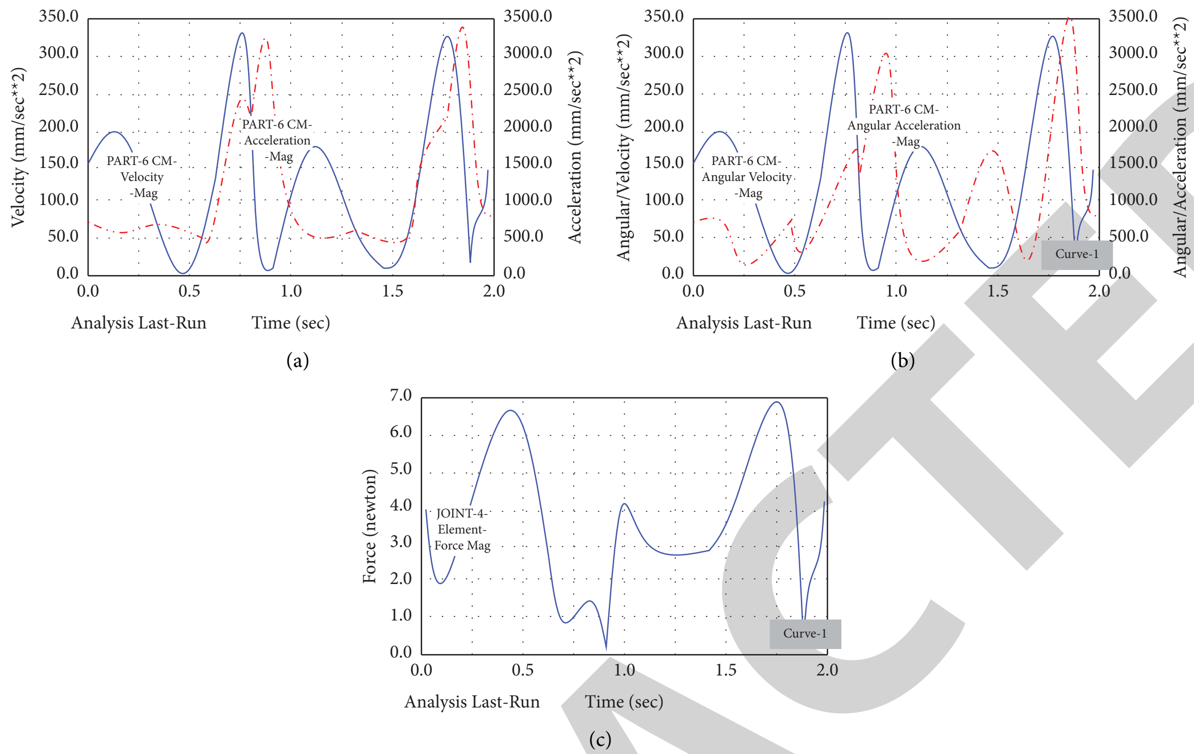


Figure 10: Simulation test: (a) the variation curve of baling needle speed and acceleration, (b) the variation curve of baling needle angular velocity and angular acceleration, and (c) the variation curve of baling needle stress.

4. Conclusion

With the adjustment of the rural industrial structure and the development of the vegetable industry, the growing area of vegetables continues to expand, and the scale and simplified management level of vegetable greenhouse bases are also increasing. However, there is no mature special vegetable harvester, and a large-scale harvester cannot meet the harvesting of small-area mountain vegetables. Moreover, the ecological characteristics of different types of vegetables are different, and traditional harvesters can only support harvesting technology and can only harvest one or similar crops. Its working mode is relatively simple, which limits the scope of use of the harvester. The bundling of vegetables after harvesting is the most labor-intensive link. This paper designs and simulates the flexible clamping and conveying device of the green leafy vegetable cutting and baling integrated machine, so as to improve the working efficiency of the green leafy vegetable cutting and binding integrated machine. Through the simulation study, it can be seen that the flexible clamping and conveying device of the green leafy vegetable cutting and bundling integrated machine proposed in this paper can meet the industrialization needs of green leafy vegetables.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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