Study on Distribution Car's Mechanical Structure Design

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Abstract. Unmanned delivery services have become a part of everyday life as science and technology have advanced. In addition to reducing labor expenses, it guarantees food safety and addresses privacy concerns for users. As a result, more and more consumers are requesting unmanned delivery services. There are many food delivery cars available on the market these days, but the most of them suffer from issues like low load capacity, comparatively few service objects, and mechanical structures that need to be further improved. Customers will naturally sense if the delivery car is inefficient, particularly during prime eating hours, these issues require immediate attention. This article proposes an intelligent car that can considerably increase the load rate and simultaneously perform several food delivery services in order to address the aforementioned issues. Simultaneously, it will incorporate an active four-wheel steering system to guarantee that the vehicle can accomplish the meal delivery mission with greater agility and comfort. The rendering model of this new food delivery vehicle is the end product of designing the perfect model and using SolidWorks modeling to make the material requirements evident in relation to the environment. Ultimately, a thorough analysis of the trolley's mechanical construction is presented, along with a detailed description of its operation, potential exceptional scenarios, and appropriate operating techniques. The new distribution car greatly increases the load capacity and work efficiency by refining the mechanical structure. It can fulfill the majority of the distribution needs for smart automobiles, depending on the particular use environment and usage in conjunction with other smart plates.

Keywords: Food delivery car, Load capacity, Turning radius, Stability, Automatic steering.

1. Introduction

Unmanned food delivery services are becoming more and more popular in today's culture since they may minimize safety issues, decrease interpersonal contact, increase productivity, and save a significant amount of labor expenditures. The mechanical structure that will be discussed later in this article is not limited to the delivery of food. It is possible to extend the mechanical structure's many additional functions, such as sending medication, expressing delivery, or papers, by appropriately adjusting the size of the load section. The intelligent food delivery car is one of the topics covered in this article. Although there are currently more sophisticated food delivery vehicles available, the most of them just have a few features. For instance, they struggle to rotate themselves in place, handle light burdens, and are unable to guarantee food balance at mealtimes. The need for this technology to mature quickly is due to the advancement of science, technology, and the changing times. Thus, this article presented and explained the fundamental mechanical design and operation of an intelligent food delivery vehicle.

When the precise working track is known, the car mostly performs a sequence of closed-loop tasks, such as receiving and delivering food inside. The system will precompile a map, arrange the use scenario's path, and emphasize the geometric connection between the path and the distribution point [1]. To increase the effectiveness of food delivery, the system will automatically determine the optimal route and configure the program to carry the most food possible. This is another justification for the huge amount of storage capacity built into the mechanical construction. The sensor will be used to implement the autonomous tracking module during the food delivery process along the predetermined path, and a number of instruction sets will be created based on the current map data to guarantee function realization [2]. To provide more convenient access to food, the mechanical model's design incorporates many doors. In contrast to the current one-to-one food delivery model on the market, it can fulfill more food delivery objectives and serve more consumers concurrently. Additionally, to enhance the vehicle's handling and stability, activate the car's front and rear tires [3]. Reduce the turning radius in the interim to make our functions more feasible in a space-constrained situation. The mechanical structure module location can be saved for the voice interaction module in advance, and it can be added selectively based on its intended use. Following analysis, the voice enhancement method-optimized human-computer interaction system achieved a 93.33% dialogue recognition accuracy, satisfying the requirement for robot human-computer interaction [4].

The goal of this research is to create an intelligent vehicle that can effectively carry out the distribution service, enhance vehicle stability, and guarantee food balance with the aid of additional mechanical systems and structures. The primary benefit of this research is that it may be used to optimize the load space and storage program parameters, thereby increasing the effectiveness of food delivery in cars. Compared to most autos on the market, this can guarantee that you finish more food delivery chores in the same amount of time. Additionally, some mechanical structural design optimization has been done to better fulfill the role of the automobile service. The active four-wheel steering system, the load component's mechanical structure, the chassis part, and a thorough explanation of how to operate it will all be covered in the sections that follow. Subsequently, deliberate over the findings of the research and assess areas that require further development. Ultimately, provide a comprehensive overview of the study and elucidate its pragmatic implications.

2. Overall Design

In order to meet the unique function of the actual food delivery in accordance with the design requirements, the new intelligent food delivery car must be designed. The advantages of the car's mechanical design are highlighted in this piece, and new features are added in accordance with the use case's specifications. This paper explains how to accomplish the work's goal and highlights the device's distinctive design.

2.1. Design of Load Device

The load device is one of the most basic parts of the intelligent food delivery car, and the load size of the car directly affects the efficiency of food delivery. There are eight load positions in the suggested car structure model, all of which are independent locations. Additionally, food safety is ensured because the food won't come into contact with that of other positions. The load device in this mechanical construction is designed as the body, which includes the main body, eight cover plates, emergency stop buttons, warning lights on the body, infrared and ultrasonic sensors, and other components. It was shown in the figure 1 and figure 2 and clearly shows the construction of the load part. For simple access to food, a 270°hinge connecting the main body and cover plate can be opened or closed. The main car's body now has all of the remaining components attached. The body of the car is wrapped in special soft materials to prevent emergency harm to customers during the delivery process, in addition to the mechanisms mentioned above to assure regular operation. With four in the front and the other six at the back of the body, the eight independently opened and closed load devices are the most noticeable feature of the mechanical structure among them. The body is rectangular in shape and is 460 by 500 by 530 mm in total. The front and rear of the upper portion measure 210 by 245 by 160 mm, and the bottom portion measures 190 by 245 by 220 mm. To maintain the food's equilibrium, the larger size kept below, the better. The technical plastic used for the body and the clear plastic used for the cover plate ensure that users can easily reach the food and that the warehouse situation can be viewed without opening the cabinet door. The cabinet door can be opened and closed by the user using a handle on the cover. Additionally, to guarantee that the function of the future access meal is realized, there needs to be a clear identification on the lid that shows the cabinet number. In order to prevent food spills during transportation due to turbulence, acceleration, or deceleration, a magnetic device is positioned between the lid and the body of the cabinet. The storage module can be upgraded to be controlled by a mobile phone, voice interactive command, or embedded screen to control the switch cabinet door by adding a password system, in accordance with the actual application requirements. The magnetic device can also be turned on.

2.2. Design of Active Four-wheel Steering

Since most application scenes don't have large roadways, the device uses an active four-wheel steering design. Active four-wheel steering design is selected to guarantee that the gadget can also accomplish steering and delivering operations in restricted channels.In the majority of food delivery scenarios, the car must accomplish 90°steering since the load is distributed between the front and back of the vehicle. For this reason, the steering system design is especially crucial. The device must be outfitted with the proper sensors in the proper locations in order for this steering system to function properly. Make wise decisions for the active steering execution phase and offer excellent control algorithm design based on particular functions. In order to guarantee the right track following active steering, feedback control is the last requirement [5]. This article focuses solely on the mechanical structure's design in order to support the aforementioned functions. It is important to leave steering space ahead of the car body, which is comparable to the gap between the car tire and the body, in order to guarantee that the four tires may spin flexibly. The gadget uses a polyurethane tire, taking into account the rubber's resistance to wear and the need for grip. The wheelbase is 320 mm, and the tire radius is 80 mm. In contrast to active two-wheel steering, active four-wheel steering allows the car's front and rear wheels to spin simultaneously, improving the vehicle's flexibility and stability with an ideal control system [6]. It to guarantee the car arrives at the delivery location designated by the system with greater accuracy and to guarantee the remaining inventory in the warehouse.

2.3. Chassis Design

The body entirely encloses the chassis module, which is located beneath it. To guarantee heat dissipation, a 5 mm radius formation is positioned on the body to set up tiny holes, with a 15 mm gap between them. It and the complete car model are clearly displayed in Figure 1 and Figure 2. The idea behind this design is that since it is intended for an inside space, waterproofing is not a concern. The chassis module primarily consists of the wheel system for the previously mentioned active four-wheel steering, as well as battery, control, radar, and four independent suspension systems. Similar ideas are put out in the Design and Research of Multi-Functional Unmanned Dining Truck regarding its operation. To enable regular operation and accomplish the shock absorption function through the shock absorption module, the two support rods in the chassis are fastened in their respective locations and coupled with special hardware [7]. The food in our warehouse will remain stable during transit if this damping function is implemented. Like the body material, the chassis is composed of engineering plastic. The mechanical industry uses engineering plastics extensively due to its low weight, ease of forming, and resistance to corrosion [8]. By using this material, body weight is significantly decreased while production costs are also decreased. Additionally, engineering plastics' qualities, such as their strong heat insulation can well suit our purposes. For food delivery services, it is possible to make sure that the meal's temperature hasn't altered significantly during the delivery procedure.

Fig. 1 Model representation (Photo credited: Original)

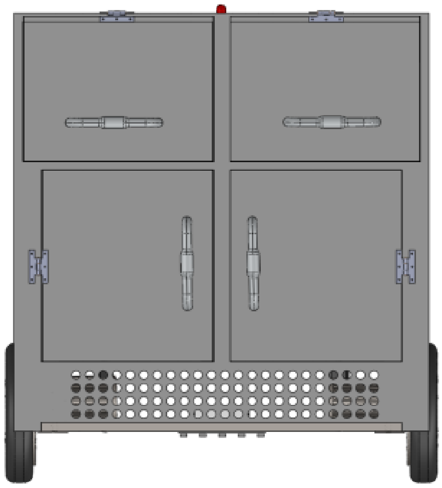

Fig. 2 Model representation (Photo credited: Original)

2.4. Use Process

Figure 3 helps to understand the delivery process. The specific operation process is as follows: the system determines the best delivery sequence based on the delivery's destination, time, and actual path. When food is delivered via the system, manually place the food in the appropriate box. The distribution area is viewed as an undirected graph in the shortest delivery path algorithm module, which also calculates the shortest path between multiple nodes. When the functions of multiple delivery services are calculated simultaneously, the linked list can be reconstructed to record the actual value of each shortest path [2]. Food delivery points are considered nodes in specific application scenarios. During the food delivery process, the tracking module's signal is primarily used to ascertain whether the food has arrived close to its destination. The location is then further pinpointed using the radar signal, after which the client receives a notification to pick up the food. Furthermore, following the conversion of the radar signal into a complete echo signal, the artificial intelligence deep learning model can be used to suppress the interference of false signals [9]. As a result, the automobile can locate nearby locations with greater accuracy. The pick-up can proceed straight forward if the arriving path leads to the pick-up site. In other situations, the food container's lid must be turned in the direction of the customer's food collection position. Depending on the particular usage of the scene, the function of the switch cabinet door can be achieved through the aforementioned mobile phone control, voice interaction function control, or body integrated screen control. Additional design can be completed once the application scenario has been established.Whichever option is used, it is imperative to make it easier for consumers to pick up their food by clearly informing them of the cabinet door code that corresponds to it. The relevant cabinet door is unlocked upon receiving the customer's order, allowing them to open it and take the food. Additionally, a module that provides the customer with the food delivery car's current location and anticipated arrival time in real time can be included to help them manage their time more effectively and enhance the distribution car's intelligence. The emergency button on the automobile can be utilized for emergency braking in the event of an emergency or if the car has not adjusted properly during the meal delivery process. Once a meal delivery is over, there shouldn't be any load just the body returning to the distribution origin to await the next delivery instruction. The distribution order may be modified to reflect the actual circumstances if there are unusual circumstances throughout the distribution process, such as waiting longer than two minutes for food delivery, or the food may be loaded back to the distribution origin and left to wait for manual processing, among other options.

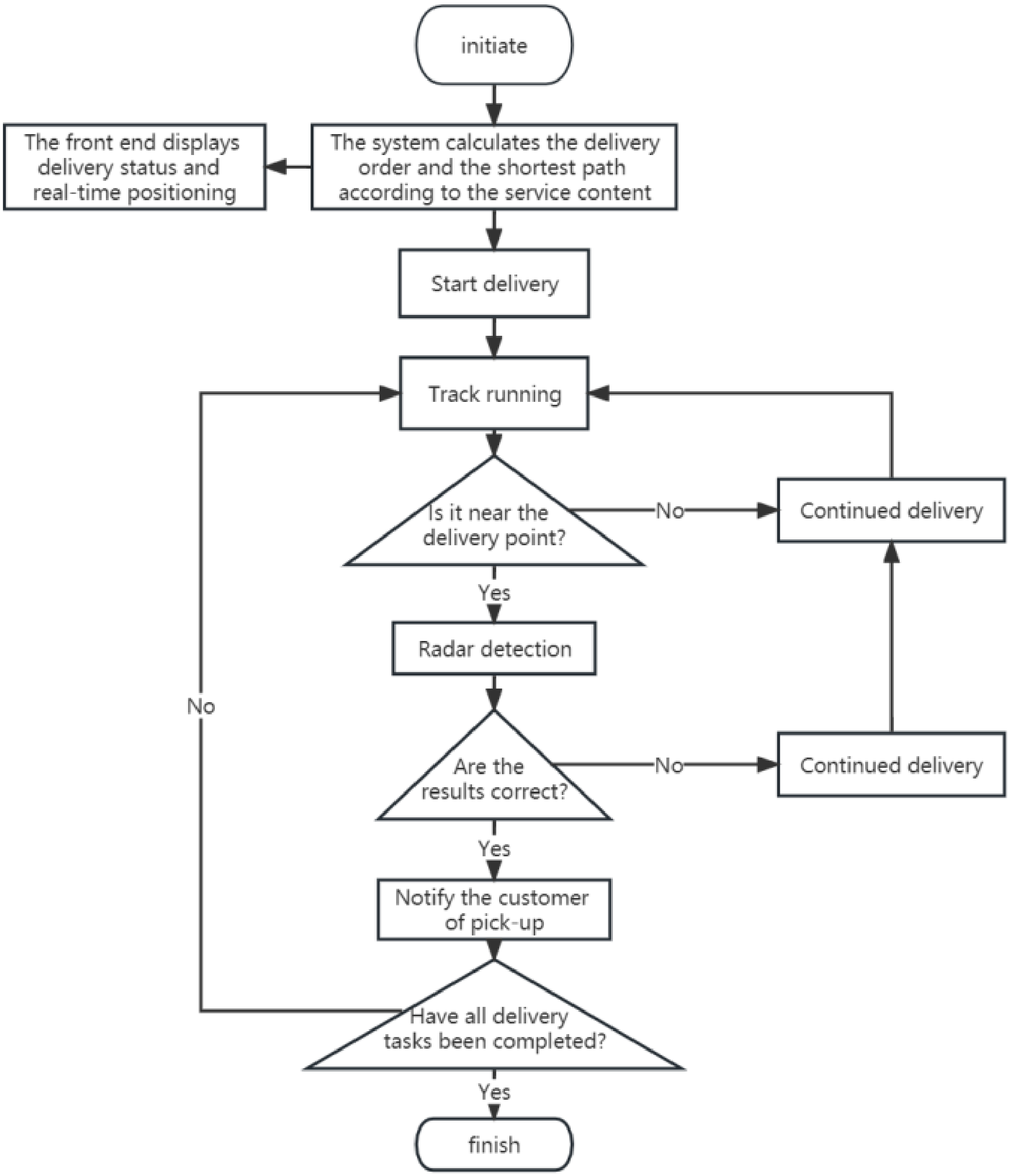

Fig. 3 distribution flow chart (Photo credited: Original)

3. Results and Discussion

This research presents the mechanical structure of an intelligent distribution car that can serve numerous objects simultaneously and significantly increase the load. One by one, each distinct mechanical structure is examined, and the discussion revolves around the practical increase in lifting weight. Additionally, it provides certain auxiliary mechanical structure-related functions that can aid the car in doing the distribution operation more effectively. The primary benefit of this mechanical construction over distribution cars now on the market is its increased load capacity, which works in tandem with other systems to effectively implement the distribution service. Additionally, a detailed description of the entire distribution process' flow is given. Indeed, this mechanical structure may be applied to the majority of distribution services and is easily adaptable to different distribution situations by adjusting a few of its dimensions. This mechanical construction satisfies modern society's demand for distribution while also significantly increasing the distribution industry's productivity. Unquestionably, one of the criteria used to evaluate the distribution service during the food distribution process is the vehicle's capacity to maintain stability. This is fully taken into account by the mechanical structure, which uses the chassis shock absorption module, the active four-wheel steering system, and the higher center of gravity food kept in the storage area below to ensure that the food can maintain good stability throughout transit. The entire distribution process is also described in detail, however additional research is required to modify the order of instructions and enhance the system in the event of unique transportation-related circumstances. Still, there are several areas that may use further development. For instance, its mechanical construction is designed to be used indoors, and its adaptability capabilities are restricted to hard interior road conditions and extreme outdoor weather environments. To assure a wider application environment for the car, it is required to further develop the mechanical structure while adapting the body material and matching the control system. Through simulation or a physical model, it is possible to determine the critical environmental parameter value at which the vehicle can typically complete the distribution. The mechanical structure or material can then be modified to accommodate a larger range of operating conditions. To reduce the amount of human resources used during the whole distribution process, the car's intelligence must also be improved. To give the delivery vehicle further capability, more interaction boards can be installed. As an illustration, the ordering service is incorporated into the system, transforming the intelligent automobile into a multipurpose service robot that can handle meal delivery and ordering. Simultaneously, smarter plates have the potential to improve customer satisfaction. Assuming the aforementioned functions are met, the body can be made more aesthetically pleasing or adapted to fulfill the needs of the car in various situations. Furthermore, in the event that the distribution automobile is utilized in alternative operational situations, its body size and mechanical configuration must be carefully updated and adjusted in accordance with the particular use scenario.

4. Conclusion

This study uses SolidWorks modeling to create a rendering model of a distribution car's mechanical system. The new distribution car's design drawing is displayed in this publication. When combined with the particular information provided in this paper about the important components, it is possible to comprehend the hardware design of this mechanical structure. A car with a single distribution object and low distribution service efficiency can be effectively enhanced by raising the load capacity and working with other systems. The trolley's active four-wheel steering system improves its flexibility and stability during distribution. The food delivery car's unique needs are further met by the chassis's implementation of the shock absorption function. This mechanical construction can be used for the distribution service of various settings by changing its size. The intelligent food delivery car is used as an example in this study to provide a detailed introduction. The car's straightforward design, large load capacity, ease of manufacture, safety, dependability, and stability when operating make it a viable option for promotion and use across most distribution industries, potentially providing a solid basis for the widespread adoption of intelligent distribution services.

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