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A Study on Design Method of Intelligent platform trolley

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Abstract. In this paper, a design method of detachable intelligent platform trolley is presented. The detachable intelligent platform trolley has three driving modes, and the rubber blanket and the cardan joint in the structure filter effectively the road surface turbulence and improve the safety of the driver. The design idea of the active wheel fixed structure and the driven steering wheel structure is emphatically introduced. At last, The results show that the right panel of intelligent platform trolley as the research object and analyses the load, static stress of the right panel of platform trolley mainly concentrated in the panel at the front and back ends and other connectors on the contact surface. In addition, the safety factor can meet the design requirements by analysis.

1. Introduction
In recent years, the numbers of private cars are still growing at an annual rate of more than 14 million vehicles. With the growth of private cars, road congestion is more and more serious, traffic accidents happen frequently. Although China's public transport network is also constantly improving, since China has the large population base and uneven population, especially in large cities, public transport system is still unable to effectively alleviate traffic pressure. The platform trolleys rising at domestic and foreign greatly ease the traffic pressure as a means of transport. Intelligent platform trolley is a kind of portable balancing vehicle, which has the advantages of intelligence, light weight, portability and easy manipulation. Therefore, from the point of view of traffic, intelligent platform trolley is undoubtedly a better choice to ease traffic and solve short distance. From the reliability and practicability of the short distance travel tools, the intelligent platform trolley has a great advantage. Feedback from the market on the existing smart flat trolley, people look forward to this product and the heat is very high.

The main purpose of this paper is to design a better intelligent platform trolley. Many researchers have studied many different types of platform trolley. For example: Zhang [1] proposed a portable adjustable platform trolley that reduces the labor intensity of the repairman's chassis maintenance under construction machinery. Cai [2] has studied a hand based obstacle crossing platform trolley, which includes flat body, wheel support and oscillating push rod. Liu [3] developed a new type of universal wheel platform trolley consisting of a flat car body and four universal wheels. Zhao [4]
introduced an electric platform trolley for processing workshops. Li [5] studied a manual platform trolley, which has the advantages of labor-saving steering, flexible handle and convenient operation. Zhang [6] proposed a platform trolley for unloading, which greatly reduced the handling strength.

2. Design scheme of separable intelligent platform trolley

As a result of integrated intelligent platform trolley driving mode shown in Figure 1 is relatively simple, the road bumpy filter is not obvious, the volume is fixed, and a single storage and power consumption cannot drive. To this end, this paper designed a detachable intelligent platform trolley, this design has a three driving modes which include single-mode driving mode, semi-linked driving mode and linkage driving mode. The combination of the rubber blanket and the cardan joint filter effectively pavement bump, strengthen stability, and improve the safety of the driver. The left and right platform trolley can be separated from each other and are easy to accommodate and rotate the fixed universal wheel. When the power consumption is exhausted, the utility model is used as an ordinary roller skate, and has the function of charging and discharging, and greatly strengthens the endurance of the roller skates. The structure of the detachable intelligent platform trolley is shown in Figure 2.

With the half bottom of platform trolley as an example, the monomer is independent of driving the trolley, driving is that a universal wheel hub motor drives the cardan joint, the fixed block of front wheel is a combination of two fixed block which are located respectively in the middle and below, the connecting position is bar hole, two upper and lower fixed block through the connection of black rubber blanket in order to filter pavement bump. An antioxidative silica gel pad is arranged on the front of the adjusting fixing seat at the front of the rear wheel universal wheel to control the steering force, and the front knob of the regulating seat controls the feeding of the movable block, thereby limiting the steering of the universal wheel. The two vehicle bodies are connected by a movable combined rod, and when the connection is lifted, the two cars can be independently driven; When the left and right panels of the connector are only fixed into a hinge, in a semi-linked state, during the driving process, the two cars are always in parallel, so that the two cars always maintain consistent and ensure smooth, the activities of the connection can make the car as a whole better control and filtering of pavement bumps; When the connecting piece is completely fixed, the two cars are combined into a whole, the car has better stability, and the battery and the controller are arranged in the protective box.

1—Hub motor; 2—Left and right beams; 3—universal wheel; 4—Beam; 5—Combination of fixed blocks; 6—φ8 mm pin in M5 bore; 7—Black antioxidative silica gel; 8—Adjustable seat; 9—Antioxidant silica gel; 10—Protective shell

Figure 1. Three-dimensional model of the integrated intelligent platform trolley
3. Design of important parts

3.1. Design of fixed structure for driving wheel

The driving wheel is a structure fixed to the left and right blocks by the main shaft. The design not only effectively limits the degree of freedom, but also has some adjustment function. As shown in Figure 3, the upper block at the left and right ends blocks the lower block and limits the freedom of the X-axis of the driving wheel. The lower block and the shaft are clearance fit, The locking screw is locked and hold the groove surface of shaft, so that the block and the spindle closely fit, the bar hole of the upper block and the through-hole of the under block are connected by the φ8mm pin in order to limit the degree of freedom of Y-axis capstan. The center distance of the bar hole is 3 mm, which limits the degree of freedom of the Z-axis capstan. A black rubber blanket is stuck between the upper and the lower surfaces of the upper and the lower blocks, which can be contacted softly, and has a certain filtering operation of bumpy road surface.

Figure 2. Three - dimensional model of the detachable intelligent platform trolley

Figure 3. Perspective view of driving wheel fixed structure
3.2. Design of driven steering wheel structure

The main structure of the driven steering wheel is composed of a universal wheel, an adjusting seat, a knob, a screw rod and a movable block. The main functions of the steering wheel are steering, steering force adjustment, steering angle adjustment and steering fixation, as shown in figure 4. Fixed seat and the fixed metal plate of the hub are cooperated through the plane thrust bearing to achieve the function of the free veer for driven steering wheel, the antioxidant silicone of the inner arm of the adjusting seat makes the universal wheel turn has a certain damping force and automatic back to the positive function. The movable block on the fixed seat is adjusted by the screw knob, and the distance between the rear side of the movable block and the front section of the wheel hub sheet metal determines the size of the corner. When the rear side of the movable block is close to the front section of the wheel hub sheet metal, the universal wheel is locked, and the trolley can only move forward and backward.

![Figure 4. The structure of steering wheel](image)

4. Load analysis

Load analysis is carried out by using simulation module in SolidWorks software, and the safety factor diagram is used to check whether the strength of the structure meets the requirement. Platform trolley load is 80kg. The right panel of platform trolley as the analysis object, the pressure is 40kg for the right panel of platform trolley. In this paper, the weight of 80kg is taken as an example to analyze the force condition of a platform trolley. The vertical horizontal total pressure is 80kg=984N, the left and right panels are subjected to 492N pressure. Through the analysis of steering torque, the fixed seat torque is 49N.

Taking the right plane as the object of analysis, the load analysis and safety assessment are carried out by using the simulation module of SolidWorks software, and the result is shown in Figure 5. As can be seen from Figure 5, the static stress of the right panel is mainly concentrated at the front and back sides of the panel and on the contact surfaces with other connectors. In addition, we also analyzed the safety factor of the right panel of platform trolley. The results show that the safety factor of the right panel of platform trolley is greater than 1, obviously, this design of intelligent platform trolley to meet the safety requirements.

5. Conclusion

In our life, the intelligent platform trolley is a portable means of transportation with intelligent, lightweight, portable, easy to control and so on. Therefore, the design of intelligent platform trolley has a wide range of significance. In this paper, a kind of separable intelligent platform trolley is studied. Compared with the traditional integrated intelligent platform trolley, it has the advantages of detachability, comfort and diversified driving modes. The working principle of separable intelligent
platform trolley is introduced in detail, and the design idea of fixed structure of capstan and veer structure of driven wheel is developed. Finally, the right panel of intelligent platform trolley as an example for load analysis, the result shows that the right panel of static stress is mainly concentrated on the panel at the front and back ends and connect with the other body on the contact surface.

![Figure 5. Static stress distribution map of right panel](image)

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