Design of Three-Dimensional Parking Lot for Shared Moped

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Abstract. As a product of the sharing economy, shared mopeds provide strong support for "low-carbon life, green travel", improve the efficiency of human life and work, and also provide a good solution for the "last mile" of the urban public transport system, and promote better urban transportation facilities. In view of the increasing number of shared mopeds on the road and a series of problems caused by users' random parking, this paper designs a three-dimensional parking lot for shared mopeds, which is composed of a modular bottom transportation device, an automatic battery replacement device and an automatic disinfection helmet cabinet. The shared moped parking lot can be stored in a three-dimensional storage, saving space and solving the pain point problem of road congestion caused by the disorderly parking of shared mopeds. At the same time, it realizes the three major functions of fully automatic power collection, battery replacement, and charging, and also fills the current helmet supply in the market and effectively promotes the healthy development of the shared moped industry.

Keywords: Shared moped · three-dimensional parking lot · random parking · automatic access · battery replacement

1 Introduction

Shared mopeds are kinds of transportation tools evolved from shared bicycles, with the addition of a power assist system on the basis of bicycles, also known as shared electric bicycles. With the implementation of the new national standard on April 15, 2019, some local cities have gradually relaxed the control on shared mopeds. Shared mopeds have a wider use value than shared mopeds. As major platforms steadily promote the deployment of shared electric bicycles, users' demand for shared motorcycles will be further stimulated, and the penetration rate in third and fourth tier cities will maintain a rapid growth trend especially. It is expected that in 2025, more than 8 million shared electric bicycles will be launched, with a compound growth rate of 41% from 2019 to 2025 [1].

In the post-epidemic era, people pay more attention to the risk of infection and are reluctant to have more contact with others. Therefore, compared with using traditional transportation tools such as subways and buses, users are more willing to share open transportation tools such as mopeds. With the development of technology and the

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improvement of battery life, the body of shared mopeds is more flexible and lighter, and can gradually meet the travel needs of citizens. Under the national double-carbon plan and the concept of green travel, it can be seen that the development prospect of the "capillary" model of urban travel built with two rounds of transport capacity is good.

However, as the operators of shared mopeds increase their investment, many cities have exposed the serious problem of random parking and discarding of mopeds. Randomly placed vehicles occupy a large number of sidewalks and fire exits. Relevant research data show that shared mopeds are illegal Parking problems account for 76% of illegal parking of non-motor vehicles [2]. In surrounding public places such as stations, markets, schools, shopping malls, scenic spots, supermarkets, food streets, and barbecue stalls in night markets, they often become "hardest hit areas" where shared mopeds are parked in groups. Many vehicles are crowded into a pile without order, and some are even discarded on the side of the road at random [3], which seriously affects the traffic in the city, not only affects the overall image of a city, but also requires urban management departments and shared mopeds for its huge number. Operators send a large amount of manpower and materials for operation and maintenance [4], and the cost of manual operation and maintenance accounts for almost 50% of the operating costs of the shared moped industry; in addition, mopeds are stored in the open air, and they are damaged by the sun and rain, which wastes resources while Increase the maintenance cost of the operator. According to the survey, the annual depreciation rate of the shared mopeds of Zhuhai University of Science and Technology is as high as 35%. For a campus of 5,000 vehicles, 20 operators are required to dispatch and place them. On average, 43 vehicles are damaged every day. These pain points have seriously affected the healthy development of shared mopeds in the future. To this day, my country has not yet found a reasonable solution to the problem of sharing mopeds, and it is particularly important to change the situation of shared mopeds being parked indiscriminately.

2 Industry Development Analysis

2.1 Analysis of Sustainable Development Factors of Shared Moped Industry

The development of the shared moped industry needs to start from the needs of moped users. According to research data, when using shared bicycles, netizens still face pain points such as inconvenience in returning the bike, difficulty in finding a bike, and bad weather. Therefore, users hope that shared bicycles can improve performance (64.56%) and reduce broken cars (56.41%) [5]. It can be seen that the current battery life cannot meet the needs of users, and broken cars generally affect the user experience, resulting in reduced user stickiness, Ultimately causing users to lose confidence in the shared moped industry. From the perspective of long-term development, after 2020, the population will enter the stage of accelerated and severe aging [6], and my country's labor force will become increasingly scarce in the future. The working-age population in 2035 will be nearly 100 million less than that in 2018 Humans, if the current way of manually placing vehicles is difficult to meet the challenges of the future, so the industry needs to combine technological development to solve the current heavy and inefficient vehicle scheduling methods. From the perspective of user safety, shared mopeds are faster, but cyclists seldom wear helmets, which poses a greater safety risk [7]; at the same time, shared

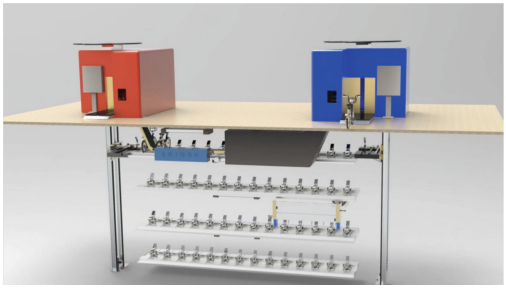

Fig. 1. Structure model of a three-dimensional parking lot for shared bicycles

helmets are still only in the supply chain, and operators have failed to solve the mess of helmets in time The problem caused users to be reluctant to wear the helmet.

3 Solutions

3.1 The Overall Structure of the Parking Lot

Combined with the analysis of the sustainable development factors of the shared moped industry mentioned above. Researched and designed a shared moped parking lot consisting of a modular bottom transportation device, an automatic battery replacement device and an automatic disinfection helmet cabinet, which has the functions of access, storage, and disinfection. When designing the mechanism of the three-dimensional parking lot, the needs of users and operators in the market were fully considered and investigated, and the structure was innovated in combination with the analysis of the mechanical structure. The overall structure of the parking lot is shown in Fig. 1.

As can be seen from the above figure, the three-dimensional parking lot is composed of an access hall, a lifting platform, a transportation platform, an ultraviolet lamp, a bottom transportation device, and an automatic battery replacement device. The lifting platform of this three-dimensional parking lot realizes the deposit and withdrawal of vehicles. The three-dimensional parking lot has two visual halls, one side is the car storage hall, and the other side is the car pick-up hall. The AGV (Automated Guided Vehicle) handling trolley moves the vehicle from the lifting platform. Go to the transport platform and store it. There is an ultraviolet lamp above the transport platform to disinfect the vehicle in real time. The specific size of the parking lot can be customized according to the actual needs, the length of the transportation platform and the number of floors of the platform.

3.2 Introduction to the Structure Principle and Process of the Car Hall

The size of the car hall is designed according to the size of the mainstream shared mopeds on the market. The car hall is equipped with a human-computer interaction screen, which allows users to choose vehicles and access them. The car hall is also equipped with a helmet cabinet to provide users with helmets. To ensure the safety of users while driving,

there is a platform for users to stand on and vehicle guide wheel grooves at the bottom of the car hall, which is convenient for users to push the vehicle in with less effort. The structure of the car hall is shown in Fig. 2, and the operation process of accessing the car is shown in Fig. 3.

Both the moped storage hall and the pick-up hall are equipped with electronic doors in the hall, and one end of the electronic door in the hall is equipped with an open recognizer. The recognizer includes an ID card recognition module, a subway card recognition module, a bank card recognition module, a face recognition module, and a mobile phone. Scanning module and NFC sensing module, users can rent vehicles from the three-dimensional parking lot at any time by using one of ID cards, traffic cards, applets, face recognition, mobile phone scanning, and NFC sensing, and can also rent vehicles at any time. Return to any three-dimensional parking lot, and these modes

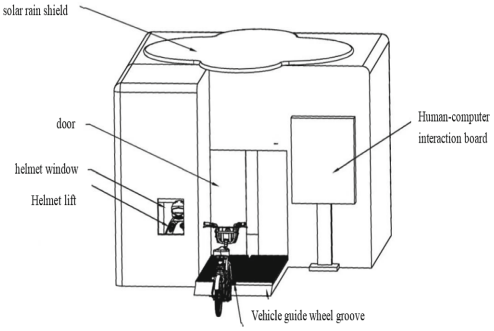

Fig. 2. Structure diagram of the car hall.

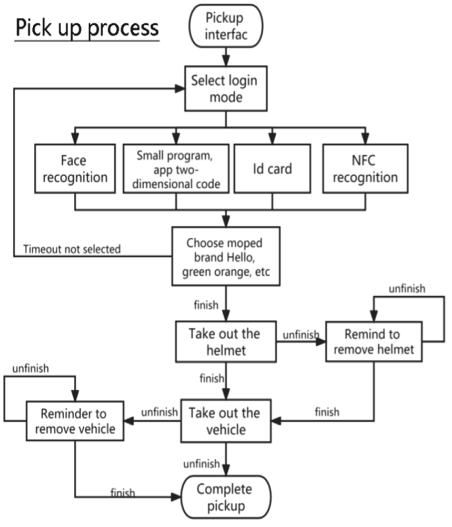

Fig. 3. Access to the car operation flow chart.

are real-name authentication to pick up the car, which is more effective in preventing children under the age of use from using shared mopeds.

There are solar rain shields on the upper end of the car hall, which can provide electric energy, can effectively use the roof of the building, and do not need to occupy land, and the solar panel power generation panel can directly absorb solar energy, thereby reducing the temperature of the walls and roof. Several appearance inspection cameras are installed in the storage hall and the helmet storage window; the appearance inspection camera adopts the optical camera multi-plane phase acquisition technology to automatically detect the health status of the vehicle. Set up a new "broken car replacement" service, and reserve a special area in the parking lot to store broken cars. The broken cars can be centrally processed and stored. Specifically, they can be stored on the bottommost car storage platform. After repairs, they can be put into use again to avoid damage. The flooding of cars in the market affects the user experience, and also avoids blind detection by the staff. The helmet detection is also similar to the above operation. The helmet transmission device comprises two helmet lifting platforms and a helmet conveyor belt between the two helmet lifting platforms. The two helmet lifting platforms are respectively located at the helmet storage window and the taking window. The helmet conveyor belt is provided with a drying Light, the role is to remove sweat, to achieve the helmet dry.

When accessing the car, the user first selects the login method, then selects the type of shared moped, and then after taking out the helmet, the vehicle will automatically move to the user standing platform in the hall, and the user will complete the pick-up. When storing the car, the user places the vehicle in the designated position on the standing platform, puts the helmet in, clicks on the control panel, and the system will automatically recycle the helmet and vehicle.

3.3 Introduction to the Structure Principle and Process of the Car Hall

There is a wheel clamp on the lifting platform. When the user sends a parking signal through the interactive interface, the wheel clamp will be stretched out because the motor rotates the gear, and then the gear and the rack are meshed and rotated to move the vehicle from the hall to the platform, and then The rise and fall of the lifting platform is controlled by a servo motor, and there are slide rails on both sides to assist in enhancing the stability. It lifts to the height of the storage rack, and waits for the AGV moving vehicle to move the vehicle out of the lifting rack.

Through the screw rod, slide rail, and bottom infrared distance measuring device, the servo motor controlled by pulse sequence is used for driving, ensuring stable and accurate operation of the motor, and achieving the lifting function of the lifting platform. The infrared rangefinder uses the principle that the infrared signal encounters different distances from obstacles and the intensity of reflection is also different to detect the distance of obstacles. The infrared rangefinder has a pair of infrared signal transmitting and receiving diodes, the transmitting tube transmits infrared signals of a specific frequency, and the receiving tube receives infrared signals of this frequency, so the infrared rangefinder is installed at the bottom of the lifting device, and the height of the bottom of the distance can be measured. The lifting structure is shown in Fig. 4.

Using a rack and pinion structure and a slider mechanism along with a cylinder to control the opening and closing of the fixture, the vehicle is clamped from the hall onto

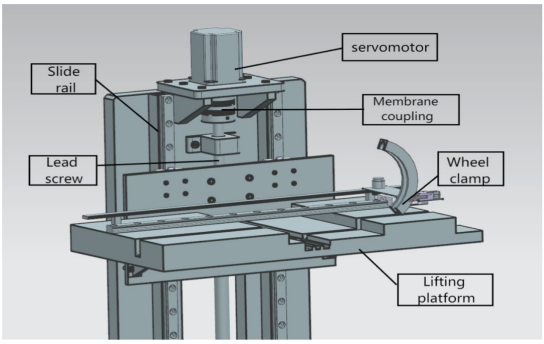

Fig. 4. Schematic diagram of lifting device.

the lifting platform. The same is true for vehicles moving from the lifting platform to the car hall. The pick-up process from the cab is shown in Fig. 5 and Fig. 6.

AGV mobile car pickup is shown in Fig. 7.

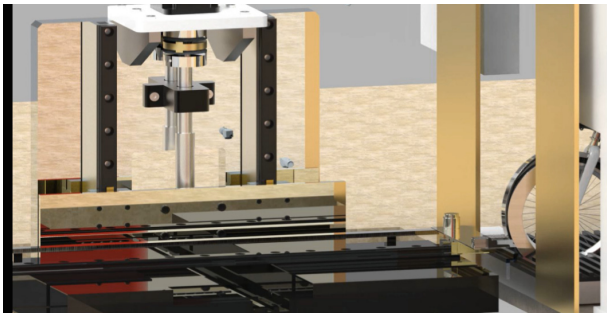

Fig. 5. Take out the diagram of the garage clip1.

Fig. 6. Take out the diagram of the garage clip2.

Fig. 7. AGV moving clamp removal diagram.

3.4 Design Principle of the Bottom Transport Device

At present, there are mainly the following types of storage traversing methods in the parking lot: belt drive, chain drive, rack and pinion, AGV steering wheel drive, etc., and their respective characteristics are shown in Table 1.

Based on the comparison of the above-mentioned traversing methods, the horizontal movement accuracy of the car body is required to be relatively high, and the installation method needs to be relatively simple, so the AGV steering wheel drive type is selected.

The mobile trolley device consists of 1. Locking mechanism 2. Electric actuator 3. M3508 motor 4. Gear transmission group 5 wheel set, the wheel set is composed of rudder wheel and load-bearing wheel, through the rudder wheel to achieve movement, through the load-bearing wheel to support the body gravity, balance the entire moving device. The structure of the AGV mobile trolley is shown in Fig. 8.

The moving device on the transport platform moves to the lower part of the vehicle body. The moving device is driven by the M3508 motor to move the steering wheel. The lifting and opening of the locking mechanism is realized through the electric push

Table 1. Transverse structure advantages and disadvantages

Types	advantages	disadvantages
Belt drive	It can be used for transmission with large center distance, stable operation, overload can slip, no noise, etc.	The outer contour size is large, elastic sliding and the shaft and bearing are stressed by large forces
chain drive	No elastic sliding, accurate average transmission ratio, reliable work, high efficiency, large transmission power, etc.	High cost, easy wear, poor stability, noise and impact in motion, etc.
Rack and pinion transmission	High transmission power, stable operation, stable transmission ratio, etc.	High manufacturing and installation accuracy, high cost and low life

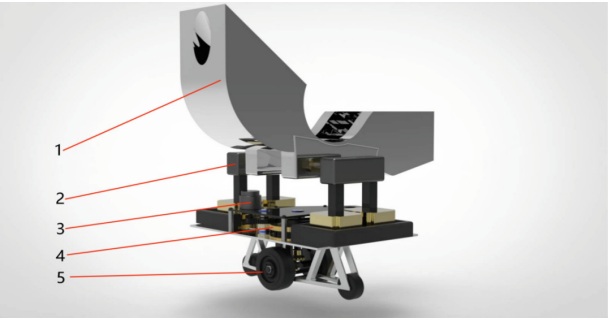

Fig. 8. Structure diagram of AGV dolly.

rod. When the locking mechanism overlaps, it is mainly generated by the energized solenoid. Electromagnetic force realizes tight locking and loosening. When the locking mechanism clamps the car body, the car moving device translates to drive the car to move to the next point. This process uses pulse sequences for position control, and the PLC side requires position control module calculations to ensure stable and accurate operation of the motor. Control the motor to return the transfer device to the starting point.

Under the storage platform on each floor, a cantilever displacement is made of elastic sensitive elements, and an energy storage spring made of elastic sensitive elements is used to drive the electrical contacts to complete the conversion from gravity change to electrical signals, which will be transmitted to the display screen on the surface door, showing the parking space margin on each floor.

The locking mechanism is designed according to the car model, which is more reliable than other clamping methods. It can be adapted to all car models on the market by the simply replacing locking mechanism, and other objects can be transported as required.

Considering the brand applicability of the parking lot, we chose to analyze the larger brands of shared mopeds on the market, and then conducted research and analysis on Hellobike, Meow, Meituan, and Qingju. Table 2 shows these four shared motorcycles main parameters of. From the main parameters of the four types of motorcycles in Table 2, it can be seen that the space occupied by a moped is about: length 1800 mm* width 800 mm* height 1200 mm, and weight 15 kg, so the entire parking space is about length 7400 mm* width 2000 mm* height 5000 mm.

Considering the rust problem of steel, the surface of steel is coated with varnish. There is a turntable at the four right angles of the transport platform, and the steering angle is controlled by the servo motor, which is used to change the direction of the AGV mobile trolley, so that the AGV mobile trolley can move the car to the lifting platform and then circle to the pick-up point to achieve a cycle. Effect. The structure of the storage rack is shown in Fig. 9.

Table 2. Related parameters of shared motorcycles.

bike type	wheel diameter	Car length	Vehicle width	car height	quality
hello bike	660.04 mm	1600 mm	600 mm	1000 mm	15 kg
meow out	600.96 mm	1560 mm	600 mm	910 mm	15.5 kg
Mei tuan	660.04 mm	1650 mm	600 mm	900 mm	15 kg
Green orange	700 mm	1700 mm	410 mm	1100 mm	15 kg

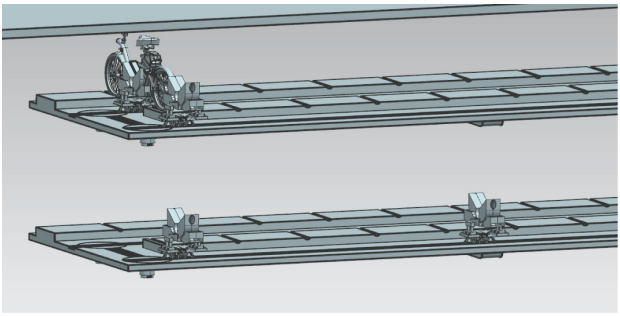

Fig. 9. Storage rack structure diagram.

3.5 Operation Principle of Automatic Power Changer

When the operator increases the battery capacity, it will increase the weight of the vehicle body and increase the risk of riders. Therefore, from the perspective of power safety and reliability, if non-contact wireless charging is used [8], the effect of increasing battery life can be achieved, while reducing the frequency of manual power exchange. Moreover, the wireless charging method has a low thermal effect. Therefore, the iNPOFi wireless charging method is used in this design to charge the battery.

In this design, the storage platform is arranged above the automatic battery change device, moped storage hall is provided with a battery power wireless transceiver module, the battery power wireless transceiver module for Bluetooth detection transceiver module, each moped battery is provided with a battery surplus emission module; Automatic battery changing device comprises a battery changing manipulator and a battery charging cabinet, and is located in the front of the battery charging cabinet, the battery charging cabinet is provided with a double platform, the double platform is provided with a plurality of battery mobile car, the battery mobile car includes a battery load plate, battery load plate is provided with a plurality of pulleys at the lower end, Charging cabinet adopts wireless charging technology to charge the battery, both ends of the double-layer platform are provided with a lifting device compatible with the battery mobile car, the upper end of the double-layer platform and the lower end of the other end are provided with a horizontal pushing device, the horizontal push rod can promote the battery mobile car in the upper or lower level of the double-layer platform lateral movement, the battery to replace the manipulator is a six-dimensional mechanical arm,

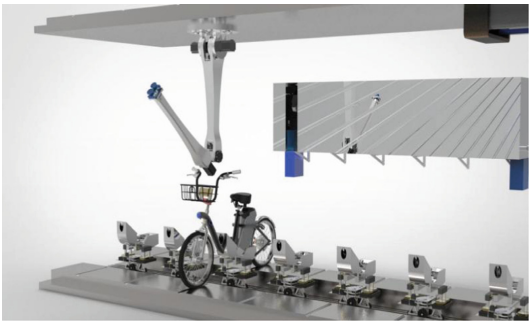

Fig. 10. Fully automatic charging device design diagram.

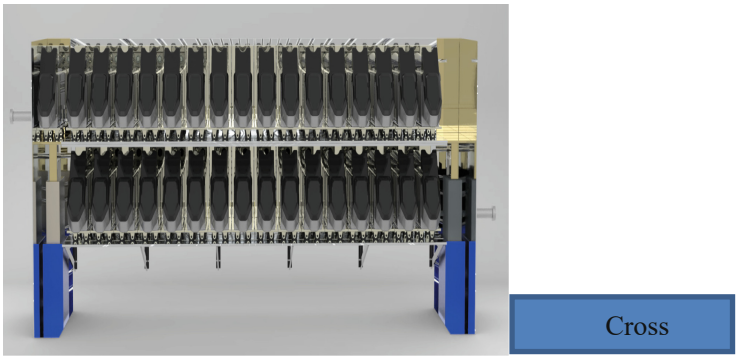

Fig. 11. Battery charging instructions.

The six-dimensional mechanical arm consists of a fixed arm, movable arm and a sucker. The mechanical arm end uses a strong sucker, so it can adapt to the vast majority of batteries on the market. Each arm has an electric push rod, and the arm is connected by bearings. The mechanical arm will take out the battery and place it in the battery charging cabinet, and take out another fully charged battery and place it in the vehicle to complete the task of replacing the battery, effectively improve the vehicle use efficiency and user experience, and realize unlimited mileage of electric vehicles. Figure 10 shows the automatic power changing device, and Fig. 11 shows the battery charging cabinet.

The battery charging cabinet adopts air cooling and water cooling for heat dissipation. Air cooling is to improve the flow rate of air heat dissipation, water cooling is to use water to absorb heat evaporative heat dissipation, through water cooling, air cooling real-time control of the temperature of the charging cabine.

4 Conclusion

This research design starts from the needs of moped users, aims to provide a planning opinion for urban construction, propose a solution for shared moped operators, improve the city's technological level and living standards, solve the market development problems of shared mopeds, and alleviate parking congestion. Sharing mopeds in the first-

and second-tier markets will accelerate their penetration into third- and fourth-tier cities and below, so that more people can feel the convenience of shared mopeds. Three-dimensional cities are a new trend in the vertical development of urban space in the future [9]. Only through three-dimensional In order to maximize the space utilization, a three-dimensional parking lot was designed to alleviate the congestion problem.

For urban construction, this project can alleviate the potential safety hazards caused by shared mopeds ("one car, one brand, real name car"). Through the three-dimensional structure, the public space is greatly saved, the problem of urban management is solved, and the convenience of the times is popularized to everyone.

For shared moped operators, this project can increase platform revenue from expanding the market, increasing the number of users, improving customer loyalty, etc., reducing vehicle damage from anti-theft, anti-fall and anti-vandalism, and saving a lot of manpower and material resources.

At present, there are specific implementation plans for the construction of different regions. The multi-dimensional parking lot can be built into above-ground and underground types, and the above-ground parking lot can be built in the existing urban area or the underground type is built with the topographic advantages of the automobile parking lot; The construction of underground parking lots in urban areas that are being planned or to be planned achieves the same effect while saving costs.

This research has solved to some extent the problem of traffic in the city, but the actual operation is still very limited. How can I change the transportation? There are still a lot of problems in demand, such as the capacity of this problem, which can be used by the gray scale calculation method to calculate the dispatch volume at a certain time, the retransmission personalization design request volume and the vehicle volume.

Nowadays, all countries in the world are facing the problem of population aging, and human resources will become more and more scarce in the future. All countries are concentrating on breaking through their own technological level and vying to catch up with the third industrial revolution, hoping to improve domestic resources. The average situation improves the people's happiness index, but most of the current work is to use the skills of personnel to make up for the lack of machines and management [10]. A waste of limited manpower also limits the development of the sharing industry to a certain extent and limits the progress of socialism in our country. Automation technology must not only be used in high-tech fields such as chips, but also in complex and inefficient fields, freeing up human resources to do more valuable things. "People are the most decisive force in productivity." [11], only by liberating people from low-level labor can we give full play to human wisdom and achieve greater innovation. Although this study only proposes innovative designs in the shared bicycle industry, the application of automation technology in the complicated and inefficient life, this idea penetrates into the heart of every cyclist.

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