

Development Space And Prospects Of Self Balancing Car

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Abstract. The balance car is one of the types of balance robots that keep the machine in balance according to the constant adjustment of the sensors and controllers of the machine itself. As a basic balancing robot, the two wheeled self balancing robot not only has the characteristics of simple structure and program, small volume, but also can realize the rotation movement in a small radius, which proves that the motion of the balancing vehicle itself is flexible, and it is very suitable as one of the tools of urban traffic. As a new tool, balance car is in the stage of rapid development. On the premise of briefly comparing and analyzing the principles, characteristics and backgrounds of different balance robots, this research summarizes the development trend, advantages and disadvantages of balance cars in the current market, and provides targeted development suggestions based on objective analysis.

Keywords: Self balance scooter; Avoidance wheelchair; Robot.

1. Introduction

As the market demand for balancing technology grows, the degree of development of balancing technology will have a direct impact on key development areas such as driverless cars in the new energy sector, aircraft in the aerospace sector, and surgical robots in the biotechnology sector [1]. Therefore, balancing technology is a topic of great interest in both the industrial field and the biotechnology field. The problem of maintaining an unstable equilibrium state is a highly demanding problem in the field of control [2]. The increasing number of international hot spots focusing on this field also shows the importance of self-balancing technology in various fields. One of the key developments in this field is the self-balancing technology [3].

The so-called self-balancing control system is characterized by taking different displacement directions including the system itself as the control object, and making the system react to the change of parameters through the output of the control system program, so as to achieve a certain control range and make the corresponding displacement operate in a stable state, that is, the self-balancing control technology [4]. The control system with the center of gravity on top and the pivot point on the bottom, which appears in the most primitive balancing car, is a basic self-balancing control system. Different self-balancing control systems have different characteristics because the control system program can be adjusted according to different requirements [5]. Compared with the traditional self-balancing control system, some self-balancing control systems can switch between the load state and the operation state [6]. In the load state, the system not only needs to maintain static balance, but also needs to ensure a smooth transition to the motion state, and needs to adapt to the balance characteristics of this state in time when the motion is switched. These characteristics determine the complexity of system control, so solving the stability of the system requires comprehensive consideration of various control theories and control methods. This paper focuses on the system analysis of self-balancing robot, two-wheeled balance vehicle and automatic obstacle avoidance wheelchair, and further illustrates the importance and development space of self-balancing control system in these application fields [7].

This article focuses on the principle and application market of self-balancing technology from two different fields, mechanical and biotechnology, and also analyzes the characteristics of self-balancing technology for different applications, including self-balancing robots and counterbalanced vehicles.

2. Mechanical field

2.1. Self balancing robot

2.1.1. Principles of self balancing robot

Self-balancing robots are robots that are balanced by the constant information interaction between the sensor and the controller so that the robot itself is corrected accordingly for changes in displacement parameters in each direction and part of itself [8].

When the balance robot deviates from the balance position (vertical position) and leans forward, the sensor collects the information and transmits it to the microcontroller for calculation and judgment. The controller will send the signal to the output device (for example, the wheels of the balance car) and then make a response to move forward to adjust the machine to the balance position; Similarly, when the robot tilts backward, the output device will move backward. In this way, the robot is always in the dynamic process of tilt judgment and motion adjustment, so that the balance robot is always kept near the balance position to achieve a dynamic balance. The principle simulation of balance plate is shown in the figure 1.

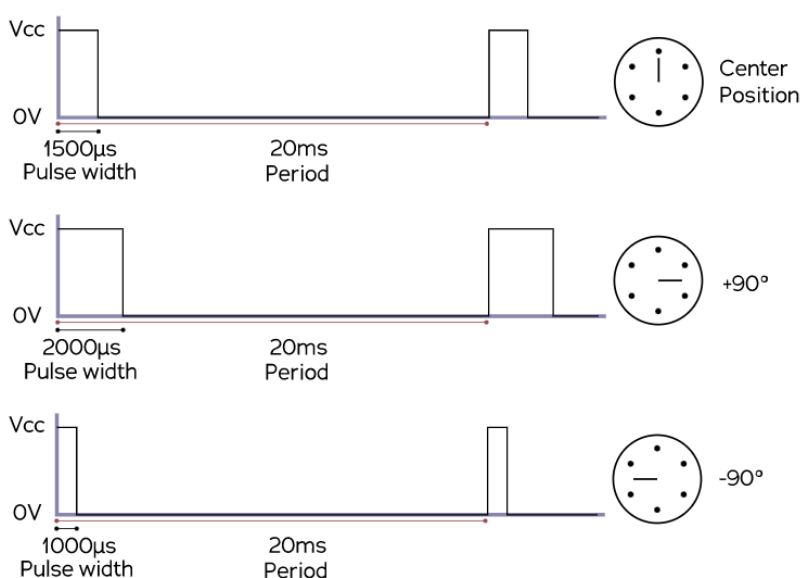


Fig 1. Balance principle under PID control [9].

2.1.2. Applications

The most common type of self-balancing robot is the arduino control system robot, which a self-balancing platform is based on PID control. Gyroscope sensors are used in self-balancing robots, which constantly send robot orientation data to the controller. Based on this data, the controller commands the motors to run forward or backward to keep the robot's position straight. The angle between the Y-axis and the robot body is zero steady state is when the platform is in a horizontal position [10]. When the platform is tilted, there is an angle between the Y-axis and the body, and the PID controller will output a signal to control the servo motors to return the platform to a steady state. The MPU6050 gyro sensor detects this angle and sends this data to the Arduino. The Arduino now performs a PID calculation and commands the stepper motors to run forward to minimize the tilt angle to zero degrees (figure 2).

As the most original research direction of self-balancing robot, the technology of two-wheeled self-balancing robot has become increasingly mature. Two-wheeled self-balancing vehicles have functions of autonomous positioning, map construction and path planning [11].

As a basic balancing robot, the two-wheeled self-balancing robot has a simple structure and procedure, a small body size and thus flexible movement, and it also has the advantage of a small turning radius. Therefore, two-wheeled bicycles are more suitable for applications with variable working environments and complex tasks, such as space exploration, terrain reconnaissance, and

hazardous materials transportation in various fields such as military, archaeology, and scientific research, etc. Also, under different programming, two-wheeled self-balancing robots can be used as educational and service robots (figure 3).



Fig 2. Balancing robot [3].

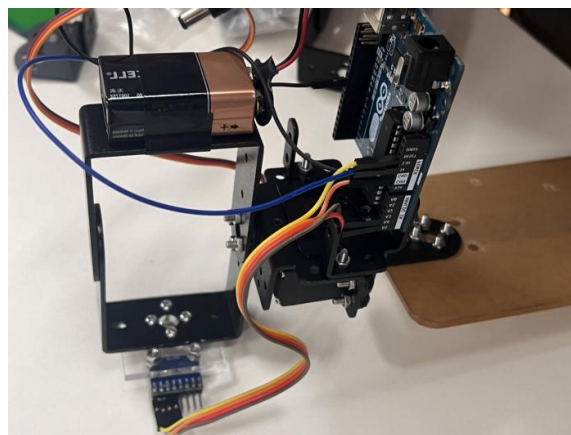


Fig 3. Self-balancing platform under PID control.

2.1.3. Current status of self balancing robot

Self-balancing robots have become a major branch in the field of robotics research and even in the entire field of control research because of their promising applications in various industries since their emergence. There are many types of self-balancing robots in the market, including wheeled, tracked, propelled, and so on. Among them, two-wheeled self-balancing robots have the advantages of low cost, simple structure and high energy conversion rate, so the market value and practical application value are relatively very high and the development prospect is very broad.

2.2. Self balance scooter

2.2.1. Background of the self balance scooter

Dean Kamen's "first self-balancing electric transport vehicle" began mass production, marking the birth of the balance car. Since then, the advantages of balance bikes have been gradually explored, and people began to continuously explore the potential advantages of balance bikes. The electric balance car first originated in 2001, at that time it was called the regulator car, body car, thinking car, balance car, Mars car, etc., was defined as a kind of transportation, its originator is Segway, located in the United States, began to engage in the development of balance car in 2001, the end of the first prototype car appeared. Figures 4 and 5 are diagrams of different types of balance cars.



Fig 4. Different types of balance cars: walking type [2].



Fig 5. Different types of balance cars: portable [3].

2.2.2. Working principle

Electric balance car as an early model of balance car, its working principle is through the control system in the posture sensor, including gyroscope, accelerometer and so on different sensors, to real-time conduct the body in the pitch state and state change rate, that is, the body balance state. The actual effect of front-to-back balancing of the car body we expect is generated by the controller based on the state data processed by these sensors, after calculating the appropriate data and instructions through the high-speed micro or ultra-high-dimensional speed controller, which drives the motor to generate the corresponding acceleration in different directions according to the state.

2.2.3. Current status of self balance scooter

Both balance bikes and electric scooters are short-distance travel tools. And the demand for balance scooters in the market belongs to a steadily increasing trend. But it is worth noting that the industry typical competitor of balance car is more of entertainment attribute and does not have tool attribute. According to the current research and development trend of the world balance car market, we can predict that the balance car industry has a complete market industry chain and a more systematic operation and research model. At the same time, the balance car market is now stable, and the industry benchmark enterprises have sufficient momentum. Through the rising trend of intelligent application requirements of urban public transport today, we can conclude that the two wheel electric balance car, which is easy to operate, green and environmentally friendly, and easy to carry, has gradually become one of the main transportation tools for fashion experts. And according to the data, the development and promotion of the two wheel balance car can also effectively reduce urban congestion and environmental pollution, which represents that the balance car also plays an extremely important role in the concept of green environmental protection, health and entertainment.

3. Biotechnology

3.1. Principles of Self balanced obstacle avoidance wheelchair

Autonomy is an important part of an individual's ability to participate in daily life. Without an independent means of mobility, individuals may experience lower self-esteem, social isolation and fear of abandonment, anxiety and depression, so the advent of self-balancing barrier-free wheelchairs can help people in need to effectively address this issue.

The principle of a self-balancing obstacle avoidance wheelchair is to consider the electric wheelchair as a movable robot, add environmental sensing components to it, and include an intelligent motion controller. The wheelchair is linked to the wheeled self-balancing robot through a control connection. Also this self-balancing obstacle avoidance wheelchair can have various functions such as hazard warning, automatic navigation, safety recognition, and path selection. Thus, the emerging sensing and intelligent control technology of this robotic wheelchair can improve the quality of life of people in need and solve their problems.

3.2. Current status of self balanced obstacle avoidance wheelchair

The demand for self-balancing wheelchairs has been steadily increasing along with the global aging problem and the increasing number of people with mobility problems caused by various diseases and accidents. As a superior mobility tool, researchers around the world have been conducting extensive and in-depth research on automatic barrier-avoidance wheelchairs because of their social relevance.

As a new application of balance robotics, the field of automatic obstacle avoidance wheelchair research contains a wide range of technical support, including vision, haptic sensing, machine control, human-machine interaction, pattern recognition and so on. Research on self-balancing wheelchair technology first began in 1986, when the wheelchair was assisted by vision for navigation. Then came the technology of placing the seat on a mobile robot platform and using human manipulation and infrared sensing for recognition and control. After decades of development, researchers around the world have developed a variety of functional self-balancing wheelchairs, including breakthrough research by WheelEasy and others at MIT in the United States. In short, there is still great room for the development of self-balancing wheelchairs in heavy multiple directions such as human-computer interaction, which makes the prospect of wheelchair discovery become even broader (figure 6).



Fig 6. Balanced wheelchair [7].

4. Prospects and discussion

From the perspective of the industrial chain, the basic guarantee for the development of balanced vehicles is the supply of various types of raw materials, including aluminum, rare earth, copper and various adaptive parts, including tires, batteries, frames, etc. The prospect market of balance car

depends on the support of dealers and the attractiveness of balance car in the market. As a major future development trend of urban transportation in today's world market, balance car manufacturing and R&D enterprises are mainly responsible for product marketing, product design and development, core component technology manufacturing and other aspects of design. Compared with the most mainstream trams and cars in the current market, the advantages and disadvantages of balanced cars are very obvious. According to the market situation, cost performance and environmental protection benefit will be one of the main marketing routes of the balance car in the future.

About the raw materials aspect, the production and R&D of balance cars have strict requirements for raw materials, which leads to a higher proportion of raw materials in the cost compared with automobiles and electric vehicles, and a downward trend in the world market in recent years. This shows that the development of balance car is constrained and restricted by raw materials to a certain extent. If in the future, relevant enterprises can solve the problem of raw materials from the root by finding new alternative raw materials or improving the utilization rate of raw materials, then the development momentum of balance car in the future will be more sufficient and even further improve its position in the market.

In the view of development stage, the balance car has been in the standardization stage since the high-speed development stage in the early 21st century. The main manifestation of this stage is that the relevant laws and regulations of the balance car are gradually strict, and there are many related competition phenomena. In recent years, due to the policy replacement and drive, the development of balance car has begun to enter the policy driven stage, the market development trend is good, and the market scale is gradually expanding. In the future, the development of balanced vehicles will even change the urban traffic structure.

As a pioneer in the development of balance robot, the technology of balance vehicle has become increasingly mature due to the accumulation of time. At the same time, due to its advantages of energy conservation, environmental protection and convenience, balanced vehicles have gradually become a new development mode of urban traffic. However, the balance car has its own limitations. Due to its strict material requirements and its inability to truly replace cars as the main means of urban transportation, the development of the balance car is also in a bottleneck period. Nowadays, the development of the balance robot industry in the market is changing with each passing day, and the policies of various countries are gradually moving towards the direction of the balance robot, which makes the balance robot become the key development object under the market science and technology competition.

5. Conclusion

This paper mainly carries out a series of analysis and description from the perspective of development space of relevant applications of balance robots, mainly balance cars. Based on the analysis, we can have a more detailed understanding of the principle, development status and development background of balance cars and other balance robots. In general, the development trend of balance car is good, but due to the limitations of its skills, the development of balance car needs more in-depth exploration. At the same time, we put forward the advantages and disadvantages of the current balance car development. In view of these existing problems, we can propose targeted solutions, so that the development of balanced cars can enter a new era in a real sense. If we want the balance car to have a better development space in the future, we need to focus on the civilian design of the balance car, so that its functions can truly apply to urban traffic and people's life requirements, so that the balance car can have a new breakthrough in the future.

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