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Research Article

The Auxiliary Function of Intelligent Mobile Robot in the Standard Training of Children's Sports Movement

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Mobile robots belong to mechanical devices. Mobile robots are commanded by humans and restricted by the principles established by artificial intelligence technology, mainly to assist humans in dangerous tasks. Intelligent mobile robot is a system that integrates perception, analysis, and decision-making, and it integrates a number of high-end technologies. It is currently the most active field of technological development. Infant sport is essentially a process of cultivating and caring for the physical fitness of children. This article aims to explore the auxiliary role of intelligent mobile robots in the standard training of children's sports movements. The physique of the early childhood stage is closely related to the entire life stage. Once there is a deviation in the early childhood training stage, there will be very serious consequences. Therefore, the mobile intelligent robot is combined with children's physical training, and it is expected that it will give correct guidance to improve children's physical fitness. This article briefly designs the mobile robot, uses two independent wheels and a robotic arm with degrees of freedom, and analyzes the forward and inverse kinematics of the chassis and the robotic arm, which provides a theoretical basis for the design of the control algorithm. This article will focus on the training of children's sports, explore the current deficiencies in children's sports, and analyze the reasons and the role that intelligent mobile robots can provide in sports training. The experimental results in this paper show that the balance ability of children standing on one foot with eyes open is mainly distributed in the second, third, and fourth levels. Among them, the second level has the largest number of people, accounting for 52%, the third level accounts for 27%, the fourth level accounts for 22%, and the other levels are less distributed. When the intelligent mobile robot assists children's movement, the child's balance ability is generally distributed in the fourth and fifth levels. Among them, the fourth level has the largest number of people, accounting for 52%, followed by the fifth level, accounting for 26%, and the third level accounting for 14%. This shows that the intelligent mobile robot is effective in guiding the movement of young children.

1. Introduction

The robot integrates a number of high-end technologies and has a very high work efficiency. It can replace humans in work and save labor costs. Intelligent mobile robot technology covers structural design, visual calibration, SLAM (real-time positioning and map construction), path planning, multisensor information fusion, and other technologies. Intelligent mobile robots have become a hot spot in the field of robotics research. There are many tasks in dangerous environments that humans cannot complete, but robots do not have this concern. Intelligent robots can complete various tasks organized and planned in various environments, which also enables intelligent robots to have vigorous vitality in various fields. For example, it can help with housework, complete diagnostic work in a hospital, complete explosion-proof work in a hazardous environment, and so on. With the continuous improvement of residents' living standards, it is the common wish of parents to promote the healthy development of children. Children are an important stage of individual intellectual development and movement development, and movement training is closely related to physical fitness. However, compared with movement training, parents pay more attention to intellectual development and standardized movement training. This has also led to a lack of scientific coaches for children's sports activities in the market. Due to the lack of scientific quantitative standards, the scope of physical fitness research mainly focuses on three aspects: body shape, physiological function, and physical fitness. There have been few studies on psychological conditions so far, so the current physical fitness testing is only limited to the physical aspect. However, the movement training of young children is closely related to their physical fitness, and scientific methods must be formulated to enhance their physical fitness. This article combines the intelligent mobile robot with the standard training of children's sports movement and hopes that it can play a role in the training of children and enhance the physical fitness of children.

The current training of young children is concentrated in the field of intellectual development, and there is a lack of necessary research on the physical function and physique of young children, which leads to a lack of scientific and reasonable training for young children. Combining intelligent mobile robots with standard training for children's sports movements can provide scientific guidance for children's sports training, enhance their physique, promote their healthy growth, improve their quality of life, formulate correct training patterns for children, and exercise properly.

China has been practicing the "people-oriented" policy, and society is paying increasingly attention to people. As a disadvantaged group, young children have become the focus of attention. Due to the lack of children's sports training mechanisms in the market, a large number of experts and scholars have carried out research in this field. Tang et al. proposed a new classification-based virtual machine placement (CBVMP) algorithm for MCC, which aims to improve the efficiency of virtual machine (VM) allocation in large cloud data centers and the unbalanced utilization of underlying physical resources. In recent years, cloud computing services based on mobile terminals such as smart phones have developed rapidly. Cloud computing has the advantages of massive storage capacity and high-speed computing capabilities, which can meet the needs of different types of users. In this context, mobile cloud computing (MCC) is booming. Through simulation experiments based on the CloudSim cloud platform, the experimental results show that the new algorithm can improve the efficiency of VM placement and the utilization of underlying physical resources [1]. Li et al. proposed a hybrid intelligent algorithm for wheeled mobile robots (WMR) to achieve trajectory tracking and path tracking navigation tasks. A new control scheme combining kinematics and TSK fuzzy control was developed to track the required position, linear velocity, and angular velocity, so that WMR is affected by system uncertainty and interference. The TSK fuzzy controller he proposed deals with general dynamic models and has good antidisturbance capabilities. For the path following problem, the improved D∗lite algorithm determines the appropriate path between the initial position and the destination. The derived path is transformed into a tracking trajectory through a time function. The asymptotic stability of the whole system is proved by Lyapunov theory. Finally, real-time experiments using the proposed hybrid intelligent algorithm on the figure-eight reference trajectory and long-distance movement proved the feasibility of actual WMR maneuvering [2]. Dayal aims to explore the possibility of a two-wheeled mobile robot (TWMR) generating an obstacle-free real-time optimal path in a cluttered environment, driven by two DC motors. During the exploration process, a new motion planning strategy called DAYANI arc contour intelligent technology was proposed, which is used for the navigation of a two-wheeled self-balancing robot in a global environment with obstacles. The developed new path planning algorithm considers five weight functions from the arc profile to evaluate the best next feasible moving point based on five independent navigation parameters. Through a series of calculations of path length and time, the authenticity of the proposed navigation algorithm is proved. Simulation and experimental verification found that the average error percentage is about 6%. This data proves that the two-wheel mobile robot can analyze the optimal path [3]. Karakaya et al. proposed a wheeled mobile robot navigation toolbox for Matlab. The toolbox includes algorithms for 3D map design, static and dynamic path planning, point stabilization, positioning, gap detection, and collision avoidance. The toolbox can be used as a test platform for developing custom mobile robot navigation algorithms. The toolbox allows users to insert/remove obstacles, upload/save custom maps, and configure simulation parameters in the robot workspace, such as robot size, virtual sensor position, Kalman filter, parameters for positioning, speed controller, and collision avoidance settings. It can simulate data from a virtual laser imaging detection and ranging (LIDAR) sensor to provide a map of the surrounding environment of the mobile robot. The differential drive forward kinematics equation and the positioning scheme based on the extended Kalman filter (EKF) are used to determine the position of the robot in each simulation step. The lidar data and navigation process are visualized using the developed virtual reality interface [4]. Karamipour et al. introduced the dynamic equations of reconfigurable nonholonomic mobile robots for space exploration and rescue operations. The dimensions of mobile robots generally remain the same, while they are programmed to determine new paths around obstacles. The purpose of developing this robot is to upgrade the mechanical structure so that its structure can be adapted to pass obstacles without path deviation. In addition, through the above reconfiguration, less motor power is required, thereby optimizing energy consumption. To this end, the longitudinal and lateral adjustment of the robot is defined. In view of the movement limitations of traditional wheels, the robot structure adopts omnidirectional wheels, and its characteristics are considered when deriving the motion equation. Therefore, the robot can move in the direction of the wheel axis. To evaluate the designed mechanism, the system was simulated in ADAMS, and the results were compared with the derived equations of motion. The research results proved that the system is practical [5]. Sunjin proposed an object tracking algorithm that can be applied to mobile robot systems based on Android. The advantage of the Android system is that it can be low-cost, portable, and versatile. To achieve this, the author implemented a particle filter-based algorithm to track objects in the input image from the smartphone camera in real time on the Android system. The proposed algorithm transmits the motion signal in the form of a data packet to the mobile robot by Bluetooth communication, so that the mobile robot can track the moving object. In addition, when a moving obstacle is detected and the object is completely occluded, an ultrasonic sensor will be used to suspend robot's motion, so as not to reduce robot's tracking accuracy. In the experimental results, the author proposed an optimal algorithm for his system by comparing the performance of other tracking algorithms [6]. Satoshi proposed a new mechanism that uses a single actuator to control the manipulation of a wheeled robot. The design uses the elements of snake board and two-wheeled skateboard propulsion. Two passive wheels, i.e., casters that can control the direction, are installed on the front and back of the robot's body. The rotor rotates above the body and uses its reaction torque to induce the body to advance. Three degrees of freedom of movement, namely, the direction of each of the rotors and the two casters, are mechanically coupled to a single actuator through a torque limiter. The stopper is used to limit the angle of the caster direction, and the torque limiter allows the rotor to continue to rotate without being restricted by stopper's range of motion. Experiments show that the rotation of the sinusoidal rotor can push the robot forward, and adding an increased or reduced offset to the rotation of the sinusoidal rotor can bend the motion of the robot [7]. Although these theories have discussed intelligent mobile robots and infant sports training to a certain extent, the combination between the two is not enough, resulting in insufficient practicability.

At present, children's movement training lacks corresponding scientific standards. Combining intelligent mobile robots with children's training can standardize children's sports movement training. In addition, the robot uses a general-purpose single-chip microcomputer to realize wheeled movement. The robot motor drive and closed-loop speed regulation technology can enable the intelligent mobile robot to effectively avoid obstacles, and the intelligent mobile robot integrates motion control and other technologies to make the robot cool and enjoy the benign control ability.

2. The Auxiliary Function Method of Intelligent Mobile Robot in the Standard Training of Children's Sports Movement

2.1. Overview of Smart Mobile Robots. With the continuous development of industrial technology, the demand in the production field is increasing. The opposite is the increasing degree of population aging and the decline in the number of labor forces [8]. To solve the labor problem, it is possible to put robots in industrial production. Robots have the advantages of flexible operation, improved production efficiency, labor cost savings, and improved product quality, and have been widely used. Although the current robotics industry is very advanced, easy to operate, and has a high level of production, the robotics industry has gone through a certain stage of development to achieve such an achievement [9, 10]. The first stage of the robot was in the middle of the last century. At that time, the robot was relatively simple and only repeated an action according to the code design. The second stage of the robot can complete different actions according to the teaching program and start to officially put it in the factory. In the third stage of the rapid development of robots, robots have certain feedback and perception capabilities. With the continuous development of industrialization, robots cover a number of high-end technologies and possess certain logical decision-making capabilities [11]. At present, it belongs to the stage of intelligence, manufacturing, upgrades, industrial automation, and robots replacing humans. To make robots more environmentally adaptable and independent, robots are required to have logical thinking and decision-making capabilities. As a representative of the robotics field, intelligent mobile robots have also become a current research hotspot. It can not only replace human work in harsh natural environments but also has different functions according to changes in human needs [12]. For example, in a medical service robot, it can observe patient's physical status in real time and provide treatment advice, and it can also deliver water, food, medicine, newspapers, and magazines to people, which greatly improves hospital's service level. Figure 1 shows the basic model of an intelligent mobile robot.

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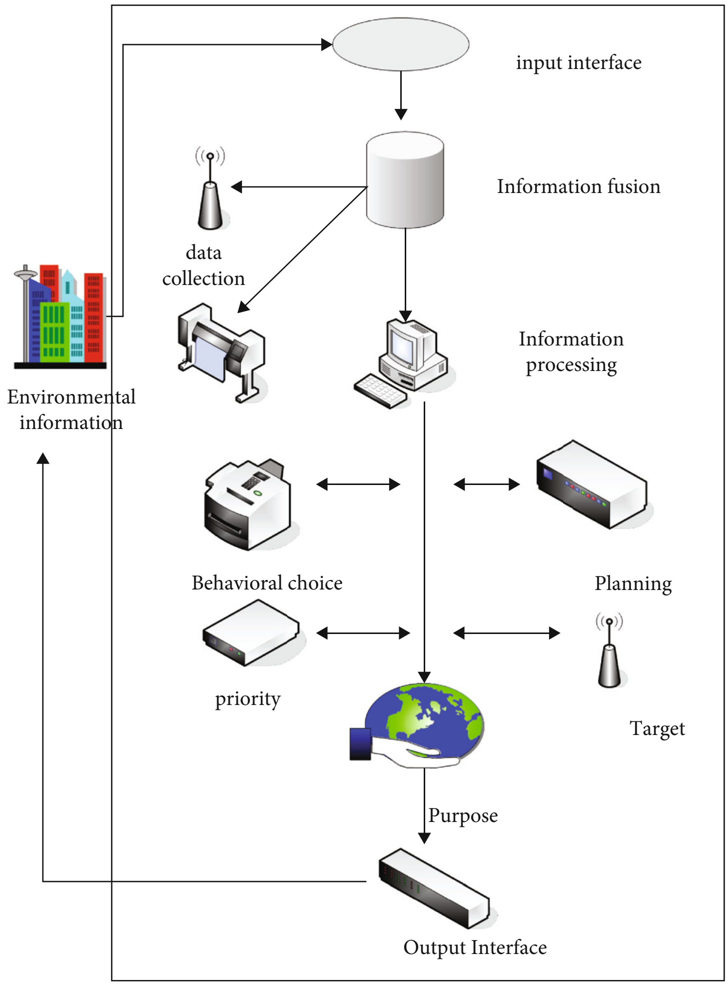

FIGURE 1: The basic model of an intelligent mobile robot.

functions according to changes in human needs [12]. For example, in a medical service robot, it can observe patient's physical status in real time and provide treatment advice, and it can also deliver water, food, medicine, newspapers, and magazines to people, which greatly improves hospital's service level. Figure 1 shows the basic model of an intelligent mobile robot (Figure 2).

China's research on robots started late, but the country has given a lot of support to high-end technologies in this century, so generally speaking, certain achievements have been made in robot research and development [13–18], taking the multifunctional outdoor mobile intelligent robot as an example. This series of robots covers multiple technologies such as path planning and information fusion, laying a foundation for the development of robots. In 2016, Xiaomi released a self-developed sweeping robot, which covers the SLAM algorithm inside. It can construct a room map based on the collected data and then complete the cleaning work according to the cleaning path. The robot has an automatic charging function. Compared with the previously developed robot, the degree of intelligence has been qualitatively improved [19]. Figure 3 shows the model of the multifunctional intelligent mobile robot system.

2.2. Robot Dynamics. In essence, the research on robots still needs to explore its power support. Understanding the internal motion correlation of the robot can provide theoretical support for the exploration of control algorithms [20]. The most fundamental problem of motion planning is to allocate robot's speed reasonably based on the current position, direction, and speed of the robot, so that it can quickly achieve the desired position, direction, and speed. The goals that the control algorithm expects to achieve include time optimization and path optimization. Figure 4 is a schematic diagram of the motion model of the intelligent mobile robot.

$$\varphi = (\partial \, \gamma \, \iota)^{\mathfrak{R}}. \tag{1}$$

Among them, φ represents the position and posture of the intelligent robot; ∂ and γ represent the seat position.

$$\dot{\varphi} = \left(\dot{\partial} \, \dot{\gamma} \, i\right)^{\mathfrak{R}}, \tag{2}$$

where $\dot{\varphi}$ represents the speed of the intelligent robot.

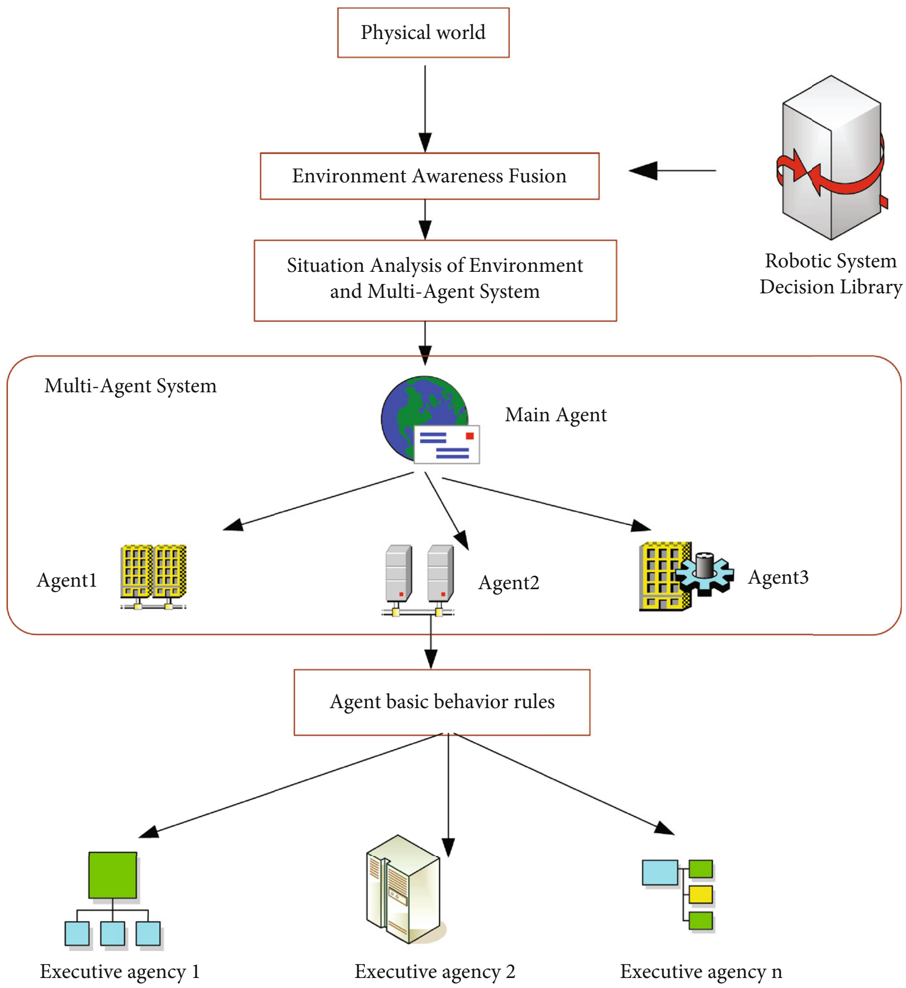

Figure 2: Mobile robot system model.

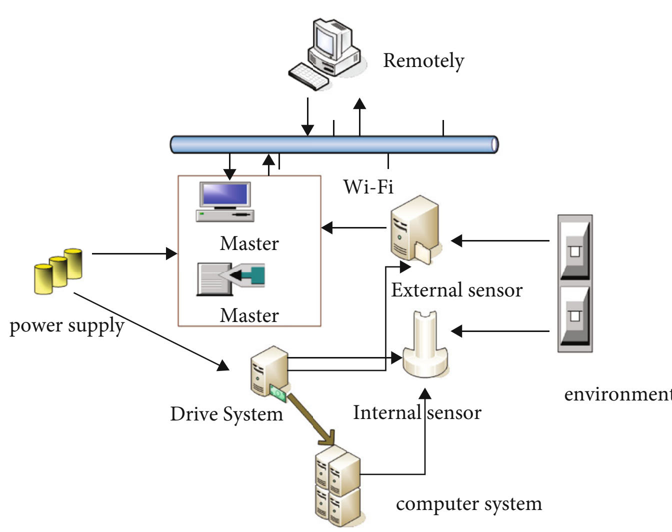

Figure 3: Multifunctional intelligent mobile robot system model.

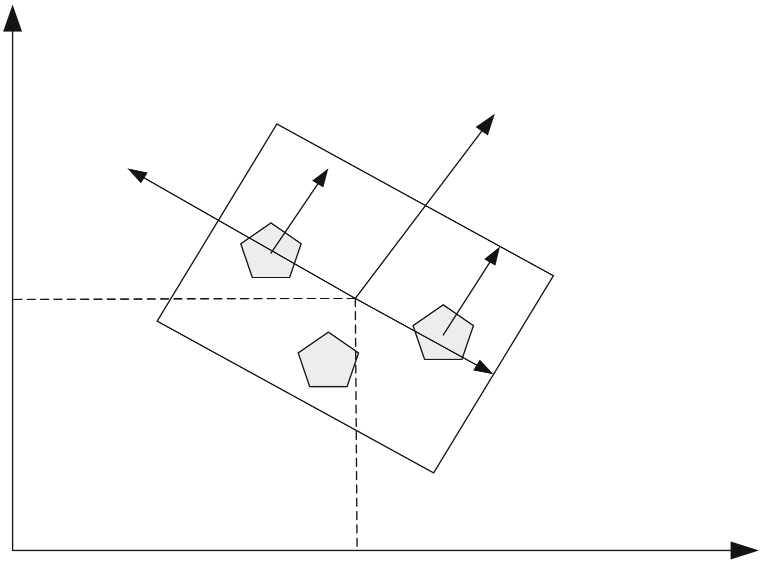

Figure 4: Intelligent mobile robot motion model.

$$W(\iota)=\begin{pmatrix}\cos\iota & \sin\iota & 0\\ \text{-}\sin\iota & \cos\iota & 0\\ 0 & 0 & 0\end{pmatrix}. \quad (3)$$

Among them, $W(\iota)$ represents the orthogonal rotation angle of the intelligent robot.

$$(-2\;0\;\mathfrak{I})W(\iota)\phi + F\aleph = 0. \quad (4)$$

Formula (4) indicates that the speed of the robot in the left direction is zero.

$$(-2\quad 0\quad \mathfrak{I})W(\iota)\phi + F\aleph_t = 0. \quad (5)$$

Formula (5) indicates that the speed of the robot in the right direction is zero.

$$\begin{pmatrix}\dot{a}\\ \dot{b}\\ i\end{pmatrix} = \frac{3}{4}\begin{pmatrix}\cos\iota & \cos\iota\\ \sin\iota & \sin\iota\\ -\dfrac{1}{\iota} & \dfrac{1}{\iota}\end{pmatrix}. \quad (6)$$

Among them, formula (6) is a summary of formula (4) and formula (5).

$$\begin{cases}\iota = \iota_0 + \dfrac{1}{\iota}\displaystyle\int_0^1 s(\partial_1-\partial_2)du,\\ a = a_0 + \dfrac{s}{3}\displaystyle\int_0^1 \cos\iota(\partial_1+\partial_2)du,\\ b = b_0 + \dfrac{s}{3}\displaystyle\int_0^1 \sin\iota(\partial_1+\partial_2)du.\end{cases} \quad (7)$$

Among them, ι_0, a_0, and b_0 indicate the position of the robot at different times.

$$\begin{cases} q = \sqrt{\dot{a}^2 + \dot{b}^2},\\ e_1 = \dfrac{2q+\alpha\iota}{3s},\\ e_2 = \dfrac{2q-\alpha\iota}{3s}.\end{cases} \quad (8)$$

Formula (9) represents the reverse motion speed of the robot.

Current inverse motion solving methods include algebraic methods and neural network algorithms [21]. In general, the algebraic method is the simplest; the algebraic method is simple to operate and has strong versatility, but requires a lot of iterative operations, is low in efficiency, and cannot get a convergent solution in the singular position, and its specific function expressions are as follows:

$$R=\begin{pmatrix} b_1b_{23} & b_1d_{23} & -d_1\\ d_1b_{23} & d_1d_{23} & b_1\\ 0 & 0 & 0\end{pmatrix}, \quad (9)$$

$$R_i=\begin{pmatrix} b_4b_5b_6+d_4d_6 & \text{-}b_4b_5b_6+d_4d_6 & \\ -d_5b_6 & d_5b_6 & \\ & b_4b_5b_6-d_4d_6 & \text{-}b_4b_5b_6-d_4d_6\end{pmatrix}. \quad (10)$$

R represents the position of each joint of the robot. $b_i = \cos\partial$, $d_i=\sin\partial$, and the motion equation of the robot proportion is $W = R * R_I * b_i * d_i$.

$$b_{23} = \cos(\partial_1-\partial_2) = b_2b_3 + d_2d_3, \quad (11)$$

$$d_{23} = \sin(\partial_1 - \partial_2) = d_2 b_3 + b_2 d_3. \tag{12}$$

According to formula (11) and formula (12), we make the robot's wrist as:

$$w = \begin{pmatrix} e_{11} & e_{12} & e_{13} \\ e_{21} & e_{22} & e_{23} \\ e_{31} & e_{32} & e_{33} \\ 0 & 0 & 0 \end{pmatrix}. \tag{13}$$

From this, the coordinate position of the wrist can be calculated:

$$a = b_1 b_{23} f - b_1 b_{23} s + b_1 (fb + f), \tag{14}$$

$$g = d_1 b_{23} f - d_1 d_{23} s + b_1 (fb + f), \tag{15}$$

$$j = d_{23} f - b_{23} s + b_1 (fb + f). \tag{16}$$

According to the coordinate axis of the wrist, the coordinate position of the chest of the robot can be obtained:

$$y_1 = x_1 x_{23} (x_1 x_2 x_3 + d_4 d_5) - x_1 d_3 x_3 d_6, \tag{17}$$

$$y_2 = x_1 x_{23} (x_1 x_2 x_3 + d_4 d_5) + x_1 d_3 x_3 d_6, \tag{18}$$

$$y_3 = x_{23} (x_1 x_2 x_3 + d_4 d_5). \tag{19}$$

Among them, y_1, y_2, and y_3 represent the 3 typical characteristic points of the chest.

Without considering that the robot encounters obstacles, the optimal solution is as follows:

$$S = \frac{\sum_{H=1}^{4} j \left| \alpha_h (g + 2) - \alpha_h (g) \right|}{\sum_{H=1}^{4} j}, \tag{20}$$

where j represents the length of the joint.

2.3. Children's Sports Training. With the improvement of living standards, people pay increasingly attention to physical health, so sports training is very popular [22]. There are many sports activities on the market today, and each sports item has a focus. Therefore, there is no unanimous view on "children's sports training" [23, 24]. However, one thing is not controversial; infant sports is the cultivation of children's physical health. It is fundamentally different from the competitive sports mentioned in our daily lives, and it is also different from children's regular outdoor activities. Based on its particularity, the state incorporates children's sports into the health field in the form of games [25]. In terms of academic concepts, children's sports include basic movements, sports games, and basic gymnastics. Although sports activities have not been fully defined academically, from the content of previous researchers, they include basic movements and gymnastics [26]. Basic movements for children include walking, running, jumping, throwing, balancing, drilling, and climbing; basic gymnastics includes changing formations and queues. This experiment is also carried out around the basic movements, Figure 5 is a schematic diagram of children's sports training:

Basic movements have a developmental process [27]. The so-called development refers to the change of things from small to large, from simple to complex, and from low-level to high-level. The development of basic work for children is related to age, and the development process is continuous and uninterrupted. The development of children's basic movements is a prerequisite for their normal life and learning [28, 29].

Children are in a stage of continuous learning. In this process, they need to be instructed in their physical training. The so-called guidance is pointing and leading. Guidance in the adult world refers to the advice of elders to younger generations. In the world of young children, guidance refers to support, pointing, and helping behavior in daily life [30]. Figure 6 shows the exploration route of this article on the basic movements of children.

3. The Auxiliary Function Experiment of Intelligent Mobile Robot in the Standard Training of Children's Sports Movement

3.1. Experimental Subjects. For the special experimental objects of the infant group, the choice of experimental actions needs to be scientific and rigorous, and it is operability under the premise of ensuring the norms of the actions. Table 1 is the related information about the subjects of this experiment.

According to the data in Table 1, two classes in two schools were investigated in this experiment. In the first school, there are 9 boys and 5 girls in class A, a total of 14 people; class B has 7 boys and 11 girls, a total of 18 people; the two classes have a total of 32 students. In the second school, there are 7 boys and 9 girls in class A, a total of 16 people; class B has 12 boys and 7 girls, a total of 19 people; the two classes have a total of 35 students.

3.2. Physical Activity Guidance. The basic sports training of young children is essential, and it will have an important impact on the subsequent growth of children. Although there is a certain understanding of this theory, there is still a lack of guidance in real life.

According to the data in Table 2, among the 75 items of actual action guidance, 40 items do not pay attention to the basic work instruction of young children, accounting for 53%. There is no corresponding guidance when performing these exercises, or even no exercise. Only 47% pay more attention to action guidance. These data show that the current exercise guidance for young children is very irregular.

According to the data in Table 3, out of the 45 unguided actions surveyed, 15 lacked emphasis on sports rules, accounting for 33.3%; 18 sports did not provide safety tips for young children, accounting for 40%; there are 5 items that do not provide guidance on children's communication principles, accounting for 11.1%; other aspects that do not provide guidance account for 15.6%.

Figure 5: Sports training for young children.

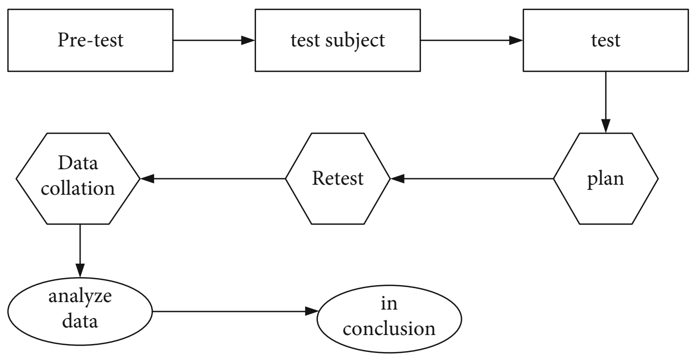

Figure 6: The exploration route of children's basic movements.

Table 1: Experimental subject information.

Category	Classes	Number of people	Number of experiments		
			Male	Female	Total number of people
1	a	18	9	5	14
	b	24	7	11	18
2	a	20	7	9	16
	b	26	12	7	19

Table 2: Distribution of movement instruction content.

Category	Number	Proportion
Ignore the action	40	53
Movement instruction	35	47
Total	75	100

Table 3: Specific cases of lack of guidance.

Category	Number	Proportion (%)
Rules	15	33.3
Safety	18	40
Principles of interaction	5	11.1
Other	7	15.6
Total	45	100

3.3. Intelligent Mobile Robot Parameters. The robot parameters used in this experiment are shown in Table 4.

4. The Auxiliary Role of Intelligent Mobile Robots in the Standard Training of Children's Sports Movements

4.1. Balanced Items. In infants, the balance ability is generally poor, and young children are a relatively active group, often an imbalance in daily activities, causing different degrees of injury to the knee or other parts. Strengthening balance training is conducive to coordinating children's sense of space.

According to the data in Figure 7, the experimental results are divided into 7 levels in the experiment. This experiment process divides the experiment objects into an experiment group and a control group. In the experimental group, the balance level of children before the experiment was generally in the third and fourth levels. Among them, the third level accounted for 32%, the fourth level accounted for 27%, the second level accounted for 15%, and the fifth level accounted for 14%, but there are fewer people in other levels. After the experiment, the fifth level accounted for the largest proportion, which was as high as 42%; it was followed by the fourth level, accounting for 28%. The sixth level accounted for 13%, the third level accounted for 12%, and the number of other levels was relatively small. According to these data, it can be found that after the professional coaching training of intelligent mobile robots, the balance ability of children improves very quickly.

Table 4: Intelligent mobile robot parameters table.

Category	Parameters	Category	Parameters
Lengths	40 cm	Drive wheel width	7 cm
Width	60 cm	Linear speed	80 cm/s
Wheelbase front and rear	45 cm	Angular speed	260 cm/s
Drive wheel length	18 cm	Weight	50 kg

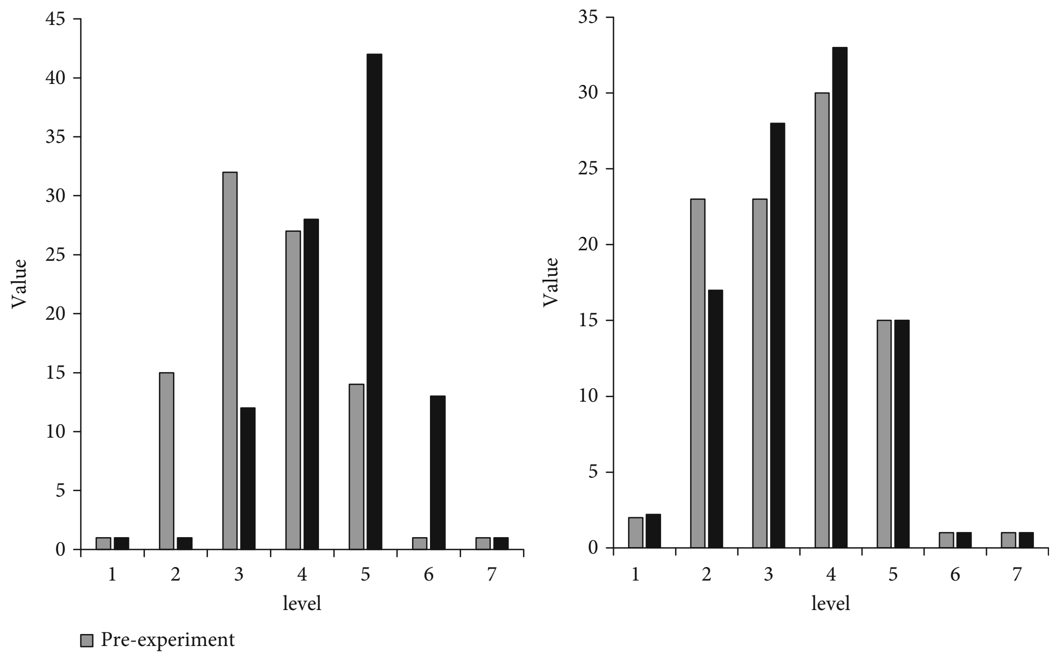

Figure 7: Standing on one foot with eyes open.

In the control group, the balance ability of the children before the experiment was generally concentrated in the third and fourth levels, which was consistent with the data of the experimental group. After the experiment, the balance ability of the children in the control group is still concentrated in the third and fourth levels, which shows that the balance training of the children has not achieved the effect.

According to the data in Figure 8, we also divided the balance of children into 7 levels and set up an experimental group and a control group. In the information of the experimental group, we can see that before the experiment, the balance ability of children standing on one foot with eyes open is mainly distributed in the second, third, and fourth levels. Among them, the second level has the largest number of people, accounting for 52%, the third level accounts for 27%, the fourth level accounts for 22%, and the other levels are less distributed. After the intelligent mobile robot coached the children's movement, it was found that the children's balance level has been significantly improved. After training, the balance ability of young children is generally distributed in the fourth and fifth levels. Among them, the fourth level has the largest number of people, accounting for 52%, and the fifth level is closely followed, accounting for 26%, the third level accounts for 14%, and the distribution of other levels is relatively small. From the perspective of the balance level distribution before and after the experiment, the intelligent mobile robot is still very effective in guiding the movement of children.

The basic information of the control group before training was consistent with that of the experimental group, and the balance ability of the children was also concentrated in the second, third, and fourth levels. Among them, the second level has the largest number of people, accounting for 50%, the third level accounts for 25%, the fourth level accounts for 20%, and the other levels are less distributed. The infants in the control group were given general action instructions. After training, infants' balance ability distribution levels were still concentrated in the fourth and fifth levels. Among them, the fourth level accounted for the largest proportion, as high as 47%, the fifth level accounted for 26%, and the third level accounted for 14%. Although the balance level of infants has improved compared with before training, there is still a certain gap compared with the data of the experimental group, which also shows that the intelligent mobile robot is effective in guiding children's movement.

Children stand upright on one foot with eyes open and closed, which can adjust children's visual influencing factors. It enables children to carry out movement training under the

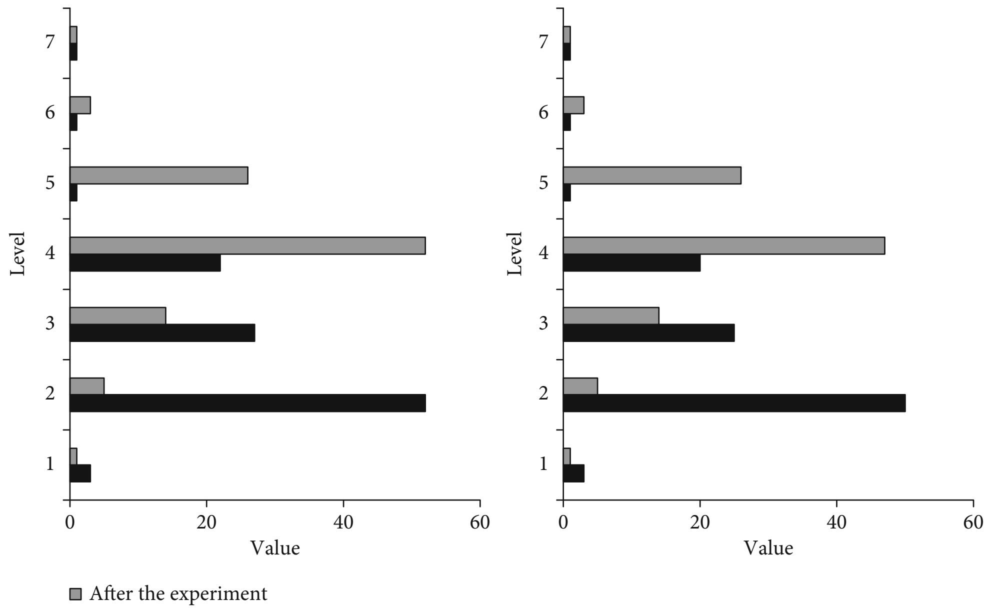

Figure 8: Standing on one foot with eyes open.

influence of visual factors and removal of visual interference, so that children can complete movement training more freely and promote the development of their own balance.

4.2. Differences in Balance Ability. According to the data in Figure 9, we divided the experimental results into 7 levels and set up the experimental group and the control group during the training of stepping with closed eyes for children. The experimental group uses intelligent mobile robots for guided action training, while the control group uses routine guided action training. Before the experiment, the balance ability of the children in the experimental group was concentrated in the third and fourth levels. Among them, the fourth level accounted for the largest proportion, as high as 33%, the third level followed by 27%, the second level accounted for 18%, the fifth level accounted for 11%, and the other levels had fewer people. After the intelligent mobile robot provides action guidance, the balance ability of young children is concentrated in the fourth and fifth levels. Among them, the fifth level accounted for the highest proportion, reaching 42%, the fourth level accounted for 28%, and the other levels were less distributed. From this data, it can be seen that the level of children's stepping with closed eyes has been qualitatively improved.

In the control group, the balance level before training was similar to that of the experimental group, and the balance ability of young children was concentrated in the third and fourth levels. Among them, the fourth level accounted for the most, up to 30%, the third level followed by 25%, the second and fifth levels accounted for 18%, and the other levels had fewer people. After regular training, the balance ability of young children is concentrated in the fourth level, accounting for as much as 52%. It can also be seen from the amplitude of the curve in Figure 9 that the level of children after routine training has not improved to a large level, and there is a certain gap compared with the results of the experimental group. These data also illustrate the effect of intelligent mobile robots in training.

The upward and forward movement is to adjust and control the dynamic training intensity of young children in different motion planes such as the coronal plane and the sagittal plane by changing the direction of movement. It can increase the movement form and exercise intensity of the limbs in the dynamic movement training of young children.

4.3. Vestibular Step Level. According to the data in Figure 10, it can be seen that the experimental process is the same as the previous experiment. Before the vestibular step training, children's vestibular step levels are mainly distributed in the fourth and fifth levels. Among them, the fifth level accounted for the largest proportion, as high as 35%, the fourth level accounted for 13%, and the third level accounted for 11%; the distribution of other levels is relatively small. When the intelligent mobile robot provides action guidance, the children's vestibular step level has been greatly improved. From the data in Figure 10, it can be seen that the number of people in the first four levels has decreased significantly compared with that before the experiment. The proportion of the fifth level has reached 68%, and the number of people in the sixth and seventh levels has also increased compared with that before the experiment.

The data of the control group before the experiment was consistent with that of the experimental group, and children's vestibular step levels were mainly distributed in the fourth and fifth levels. Among them, the fifth level accounted for the largest proportion, up to 50%, the fourth level accounted for 13%, the third level accounted for 11%, and the other levels were less distributed. According to the experiment of the control group, it can be seen that children's vestibular step level did not change significantly before and after the experiment, which shows that the

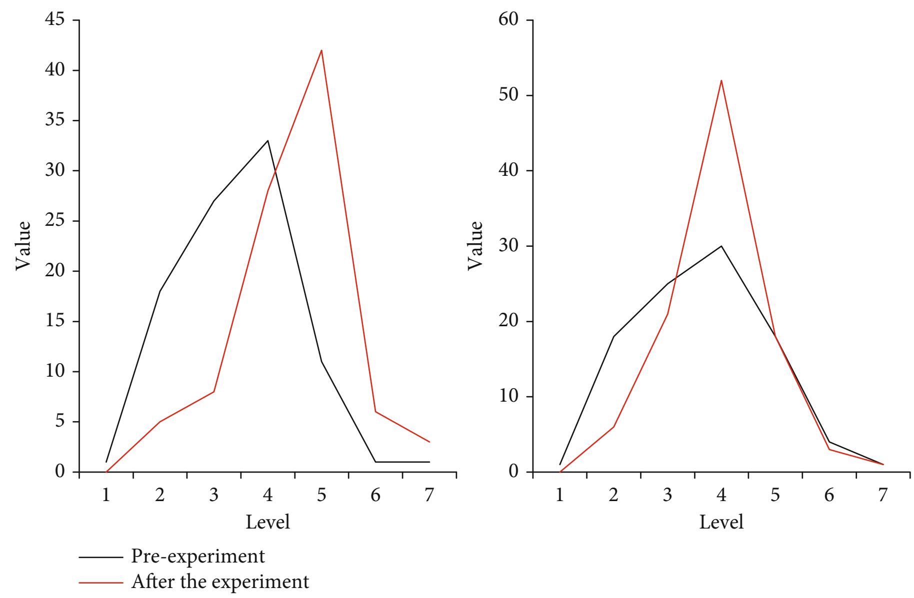

Figure 9: Stepping in place with closed eyes.

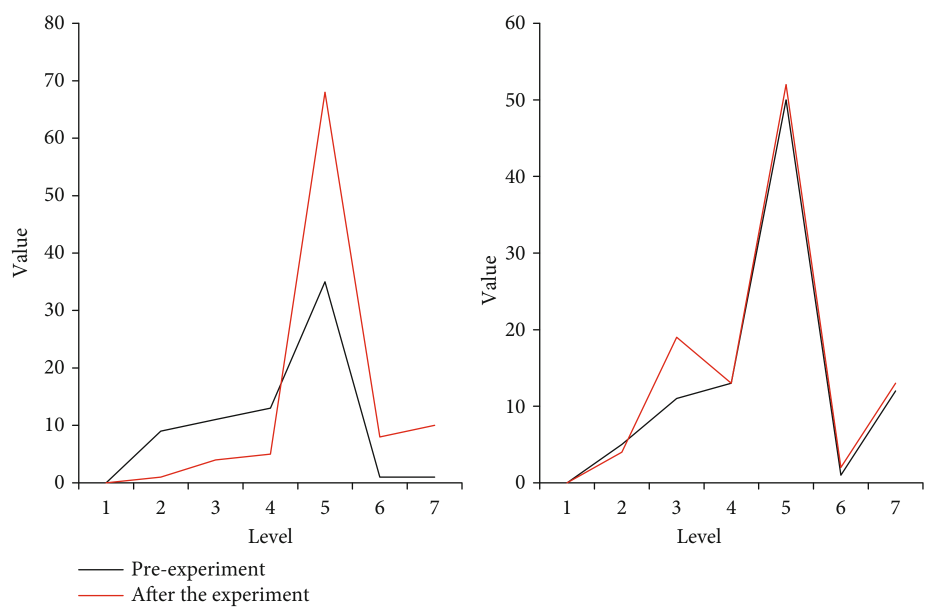

Figure 10: Analysis of vestibular step hierarchy.

conventional training has no effect. These data also illustrate the effect of intelligent mobile robots in the vestibular step training program.

5. Conclusions

Technical development will not only bring progress to the production field but also have a significant impact on daily life. The continuous development of robot technology and the continuous improvement of capabilities have enabled the continuous expansion of the scope of use of robots, and they can replace humans in completing many dangerous and complex tasks. Because young children are in the learning stage, motion training requires professional guidance, but the current market lacks such professional guidance, so people have turned their attention to robotics. This article is based on this background and aims to explore the auxiliary role of intelligent mobile robots in the standard training of children's sports movements. In this article, the following work has been mainly completed: (1) by analyzing the physical structure of the wheeled mobile robot, the motion model of the mobile robot is obtained. (2) A brief overview of children's easy sports guidance was given, and the conclusion was drawn that intelligent mobile robots can effectively assist children in sports movement training. (3) Children's movement training programs should be in line with their age, and safety education must always be given during training.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Kai Liu and Cheng Guo contributed equally to this work as co-first authors.

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