Design of basketball robot based on behavior-based fuzzy control

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Abstract
Aiming at the strong dependence on environmental information in traditional algorithms, the path planning of basketball robots in an unknown environment, and improving the safety of autonomous navigation, this article proposes a path planning algorithm based on behavior-based module control. In this article, fuzzy control theory is applied to the behavior control structure, and these two path planning algorithms are combined to solve the path planning problem of basketball robots in an unknown environment. First, the data of each sensor of the basketball robot configuration are simply fused. Then, the obstacle distance parameters in the three directions of front, left, and right are simplified and fuzzified. Then combined with the target direction parameters, the speed, and steering of the basketball robot are controlled by fuzzy rule reasoning to realize path planning. The simulation results show that the basketball robot can overcome the uncertainty in the environment, effectively achieve good path planning, verify the feasibility of the fuzzy control algorithm, and demonstrate the validity and correctness of the path planning strategy.

Keywords
Behavior, fuzzy control, robot

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Introduction
The three problems to be solved by the autonomous navigation of basketball robots are the identification and tracking of positioning and destination, as well as path planning and motion control.¹,² Path planning is the key ability of basketball robots to navigate autonomously in an unknown environment, and it is a problem that must be solved to realize intelligent basketball robots. The goal of the path planning of the basketball robot is to avoid obstacles and find a collision-free path from the initial state to the target state according to the evaluation criteria. According to unknown information and known information on environmental information, path planning is divided into local path planning and global path planning.³,⁴ There is no essential difference between the local path planning and global path planning. Local planning only considers the environment of global path planning more complicated, that is, the environment is dynamic.

The commonly used local path planning algorithm⁵ is divided into traditional algorithms and intelligent algorithms, including artificial potential field method, fuzzy logic, raster algorithm, neural network algorithm, and so on. In order to solve the path planning problem of basketball robots in dynamic environments, Lyu and Yin⁶ proposed a relatively dynamic artificial potential field

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algorithm, which regards time as a one-dimensional parameter of the planning model, and moving obstacles in the extended model. Still seen as static, dynamic path planning can still be implemented using static path planning algorithms. But the main problem with this algorithm is that the trajectory of the basketball robot is always known, but this is difficult to achieve in the real world. In this regard, Pan et al.\(^7\) introduced the velocity parameter of the obstacle into the construction of the repulsion potential function, proposed the path planning strategy in the dynamic environment, and gave the simulation results. However, the two assumptions of the algorithm make it; there is a distance from the actual dynamic environment. The first assumption is that only the speed of the movement of obstacles in the environment is considered, and the speed of the movement of the robot is fixed. These two assumptions lead to the environment of the algorithm not being a complete dynamic environment. Pao-\(^\_\)lanti et al.\(^8\) used the artificial potential field method to solve the local path planning problem of basketball robots. However, the algorithm is prone to fall into local minima, causing the robot to not reach the target position. In recent years, it has been found that it is very difficult to establish an accurate mathematical model for the obstacle avoidance process of basketball robots due to the complexity and irregularity of the environment. More attention is paid to the fuzzy logic control algorithm. Kamil et al.\(^9\) proposed a fuzzy matching path planning algorithm for robots. In order to improve the adaptability of path matching technology based on fuzzy matching to environmental changes, some scholars have proposed an algorithm that combines fuzzy matching with neural network learning. For example, Kuh-\(^\_\)ner et al.\(^10\) combine case and enhanced learning to improve the adaptive performance of the robot in the path planning algorithm which enables the robot to partially adapt to changes in the environment. And Wang et al.\(^11\) proposed a path planning algorithm combining environmental fuzzy control with neural network learning. Muñoz et al.\(^12\) proposed a behavior-based path planning control structure. It is to break up complex tasks into many simple units, which can be executed concurrently. Each unit has its own perception and actuator. The units are closely combined to form the perceptual action behavior, and multiple behaviors form a loosely coupled layer model. The main advantage of this algorithm is that the function of each behavior can respond quickly to changes in the surrounding environment, and the real-time performance is good.

The artificial potential field method is widely used due to its simple algorithm and easy real-time control, but it has local minimum problems. The grid method uses a grid to represent the environment, but there is a contradiction between the environmental resolution and the amount of environmental information storage, and the amount of calculation is large, which limits the scope of its use. The fuzzy logic method combines the robustness of fuzzy control itself with the physiological-based “perceptual-action” behavior, which provides a new idea for basketball robots to avoid obstacles in complex environments. The algorithm avoids the shortcomings of traditional algorithms and has strong dependence on environmental information. It shows great advantages and strong real-time performance for dealing with robot path planning problems in complex environments. In order to solve the above problems, this article proposes a path planning algorithm based on behavior module control for basketball robot path planning. In this article, the fuzzy control theory is applied to solve the path planning problem of a basketball robot in an unknown environment. Simulation results demonstrate the effectiveness and feasibility of the proposed path planning strategy.

**Relevant theoretical knowledge**

**Sensor model and ranging principle**

The sensor is the eye of a basketball robot and is an intelligent tool for basketball robots. The most important ability of basketball robots to achieve autonomous driving behavior is to obtain information about the environment.\(^13\) Among them, ultrasonic sensors have been widely used in robot sensing systems due to their high-cost performance and simple hardware implementation. The sensor model is shown in Figure 1. Six sonar sensors are placed in front of the robot at 20\(^\circ\) intervals on the side, and one on each side. They are divided into three groups according to the left, front, and right directions. The array of nan-arrays provides a 360\(^\circ\) seamless inspection of the robot. Each group reads the distance signal of two sensors at a time, taking the smallest of the data as the input of the group, which is the simplest data fusion algorithm.\(^14\)

![Figure 1. Sensor model.](image)

The principle of ultrasonic ranging\(^15\) generally adopts the transit time method. First, the time elapsed from the time when the ultrasonic wave is returned to the encounter with the obstacle is measured, and the speed of the ultrasonic wave is multiplied to obtain the distance between the sound source and the obstacle, as shown in the following equation

\[
D = \frac{CT}{2}
\]
Among them, the variable \( D \) is the distance between the sensor and the obstacle to be measured, the variable \( C \) is the transmission rate of the sound wave in the medium, and the variable \( T \) is the absolute temperature. The acoustic wave transmission rate in the air is as shown in the following equation

\[
C = C_0 \cdot \sqrt{1 + T/273} \text{ m/s}
\]

\[
C_0 = 331.4 \text{ m/s}
\] (2)

**Structure and kinematics analysis of basketball robot**

Figure 2 shows the kinematics model of a basketball robot. It is a model diagram of a wheeled robot with three wheels. It consists of two independently driven wheels combined with an auxiliary wheel. In Figure 2, the auxiliary wheels are not shown. The advantage of this configuration is that the mechanism is easy to construct, and the radius of rotation can be arbitrarily set from zero to infinity. Basketball robots have two degrees of freedom. The axes of the two drive wheels pass through the center point of the robot and correspond to each other. The shape of the basketball robot is circular, with its diameter \( D \) and the diameter of the two wheels \( d \).

As shown in Figure 2, the basketball robot has a centroid speed of \( v \) and an angular velocity of \( w \). The linear speeds of the left and right wheels are \( v_l \) and \( v_r \), respectively, and the angular velocities are \( w_l \) and \( w_r \). The basketball robot completes the basic movement by controlling the difference between the left and right wheels. The equation of kinematics satisfies the following equation

\[
\begin{align*}
v_l &= (1/2)d w_l \\
v_r &= (1/2)d w_r \\
w &= (v_r - v_l)/D \\
v &= (v_r + v_l)/2
\end{align*}
\] (3)

It can be seen from the above equation that when \( v_l = v_r \), the centroid angular velocity is 0, and the basketball robot moves in a straight line. When \( v_l = -v_r \), the centroid speed is 0, and the basketball robot rotates in place. When other values are used, we can easily realize the functions of forward, backward, left turn, right turn, left turn, and right turn of the basketball robot through the difference pair.

**Fuzzy control system**

Fuzzy sets theory (referred to as fuzzy sets),\(^{16}\) this algorithm takes the object to be investigated and the fuzzy concept reflecting it as a certain fuzzy set, and establishes appropriate membership function. The fuzzy object is analyzed by the related operations and transformations of the fuzzy set.

Based on fuzzy mathematics, the fuzzy set theory studies the phenomenon of inexact phenomena, and its basic idea is too flexible the absolute membership relationship in the ordinary set.\(^{17}\) In simple terms, the membership relationship of an element in a normal set to a set can only take one value in \([0, 1]\), while the fuzzy set does not explicitly define each element in \( U \) for a fuzzy subset \( A \) on the universe \( U \). Whether it belongs to it or not can only indicate how much it belongs to it, so that the membership degree relationship of the element \( u \) to the set is extended to any value in \([0, 1]\).

We define \( \mu_A(u) \) as the membership of \( u \) to \( A \), and \( \mu_A \) are the membership function of \( A \). Let \( A \) and \( B \) be the fuzzy sets on the domain \( U \), then

\[
A = \{a_1, a_2, \ldots, a_m\} \\
B = \{b_1, b_2, \ldots, b_n\}
\] (4)

The intersection of \( A \) and \( B \) is \( B \cap A \), and the set is \( A \cup B \). The complements of \( A \) and \( B \) are \( \bar{A} \) and \( \bar{B} \), respectively, and they are defined as shown in the following equation

\[
\begin{align*}
\mu(A \cap B)(x) &= \min(\mu_A(x), \mu_B(x)), \quad \forall x \in U \\
\mu(A \cup B)(x) &= \max(\mu_A(x), \mu_B(x)), \quad \forall x \in U \\
\mu(\bar{A})(x) &= 1 - \mu_A(x), \quad \forall x \in U \\
\mu(\bar{B})(x) &= 1 - \mu_B(x), \quad \forall x \in U
\end{align*}
\] (5)

The fuzzy relation \( R \) between the fuzzy set \( A \) and \( B \) is expressed by matrix, as shown in the following equation

\[
R_{A \times B} = \begin{bmatrix}
\mu_{11} & \mu_{12} & \cdots & \mu_{1n} \\
\mu_{21} & \mu_{22} & \cdots & \mu_{2n} \\
\vdots & \vdots & & \vdots \\
\mu_{m1} & \mu_{m2} & \cdots & \mu_{mn}
\end{bmatrix}
\] (6)

In the equation, the membership degree \( \mu_{ij} \) of any of the two groups \((a_i, b_j)\) satisfies \(0 < \mu < 1\).

Fuzzy logic control is a computer numerical control technology based on fuzzy set theory, fuzzy linguistic variables, and fuzzy logic reasoning.\(^{18}\) The fuzzy controller is designed according to the fuzzy control statement. The
fuzzy control theory is applied to the experimental steam engine control for the first time, and the effect is better than the traditional digital control, which indicates the birth of fuzzy cybernetics. Since then, the fuzzy control theory has been widely used in complex systems where it is difficult to establish accurate models.

Basketball robots are often in an unstructured task environment. It is difficult to establish accurate mathematical models to construct environmental information. Fuzzy control is a rule-based control that simulates human thinking according to language-based control rules. It is not necessary to establish an accurate model of the controlled object, so it is very suitable for local path planning of basketball robots.

Fuzzy control theory combines traditional control algorithms with fuzzy mathematics to study inexact objects by simulating human thinking processes. The basis of fuzzy control systems is the fuzzy set theory and fuzzy logic control. It uses fuzzy logic to imitate human thinking and controls those nonlinear, time-varying complex systems, and systems that cannot establish mathematical models. The fuzzy control system is a form of computer digital control, and its composition is similar to the general digital control system. The basic principle is shown in Figure 3.

The reasonable fuzzy controller is the core of the fuzzy control system, which is mainly composed of four parts: fuzzy, rule base, fuzzy reasoning, and unambiguous. The following four sections will be introduced separately:

1. Fuzzy
Fuzzy means that input/output variables are arranged into different membership degrees according to various classifications.

2. Rule base
The rule base is a fuzzy control language to describe control objectives and strategies.

3. Fuzzy reasoning
Fuzzy reasoning is one of the uncertain inference algorithms. It is based on the premise of fuzzy judgment. The input variable is added to a set of control rules of if...then. The fuzzy language is run according to various rules defined in the rule base. An approximate fuzzy judgment conclusion is made.

4. Unambiguous
Unambiguous converts the fuzzy value obtained by fuzzy inference into an exact control signal and uses it as the input value of the drive system. The common methods are as follows:

1. Gravity center method
First, the graph surrounded by a membership function and the abscissa is determined through each rule, and then the center of gravity of the graph is determined according to the area method, which is taken as the output.

2. Maximum membership degree method
In the output field, select the element corresponding to the maximum membership degree as the output value.

3. Coefficient weighted average method
The weighted average of membership coefficients of all elements is used as the output.

4. Membership degree limiting element average method
First, the membership function is determined through various rules, and all elements equal to a certain membership degree are found. Then, the average value of these elements is calculated and taken as the output.

Path planning algorithm based on behavior fuzzy control

Design idea of path planning

In this article, the path planning strategy is a combination of fuzzy logic control and behavior control ideas to design a path planning algorithm based on behavior-based fuzzy
logic control. According to the behavior control thought and path planning requirements, the path planning process of basketball robots is divided into two types: goal-oriented behavior and obstacle avoidance behavior. The goal-oriented behavior is the most basic task because the goal of path planning is that the basketball robot is safe and reliable to reach the destination. When the basketball robot encounters an obstacle, that is, when an obstacle event occurs, it is converted into an obstacle avoidance behavior, and after the obstacle avoidance algorithm escapes the obstacle, the behavior toward the target is continued.

The reason for using fuzzy logic to control the behavior of target and obstacle avoidance is that it can easily distinguish these behaviors according to the fuzzy information and can quickly convert the working mode of basketball robot according to the actual situation of the basketball robot in each stage. For the problem that the behavior of the traditional behavior control algorithm is not easy to describe, the conflict between multiple behaviors and the competition is difficult to coordinate; this is an effective solution, so that the whole system has good real-time and robustness, relying on these two the interaction of behavior, the basketball robot finally reached the end.

**Behavior-based control structure**

The model of the basketball robot is shown in Figure 2, with two drive wheels in the middle. Six sonar array sensors are placed in front of the robot, divided into three groups according to the left, front, and right directions. Each group has two sensors, each time reading the distance signal of two sensors, taking the smallest of them as the input of the group; this is the simplest data fusion algorithm. By controlling the two drive wheel robots, it is possible to perform simple actions such as moving forward and backward and turning left and right.

Considering the actual environmental conditions, the basketball robot control system structure adopts a three-layer behavior module, which is the trend-oriented behavior, the obstacle-avoiding behavior, and the anti-deadlock behavior, as shown in Figure 4. It is a priority-based behavioral decision-making algorithm in the containment structure proposed by Pathan. Each layer of the behavior module can only obtain the sensor information of the corresponding part and complete part of the work. Each layer has different priorities. Among them, the de-locking layer has the highest priority, the emergency avoidance is second, and the target has the lowest priority. The layers are processed in parallel to optimize the behavior of the robot as much as possible. The trend toward the target behavior is the most basic behavior. When the system has no external events, the robot will search for the target and generate the behavior toward the target. When the obstacle occurs on the current side, the current task will be suppressed and the emergency obstacle avoidance behavior will be generated.

![Figure 4. Robot behavior control system structure.](image)

When the robot wraps around the obstacle, due to the complicated environment, the robot may cause a deadlock, resulting in the task not being completed, and the deadlock behavior is generated. The final task, which relies on the interaction between the various behavioral modules, successfully reaches the end point on the premise of protecting the robot itself.

Behavior-based control algorithms divide the system into different levels, namely perception and action. And the two are studied relatively independently. In other words, it breaks down complex tasks into many simple units that can be executed concurrently. Each unit has its own perceptor and actuator, which are tightly coupled to form a perceptual action behavior. Multiple behaviors are coupled to each other to form a hierarchical model. They generate inhibition, prohibition, and activation information through competition and arbitration to coordinate each other’s actions so that external observers can have an orderly action pattern. This orderly action pattern shows some form of intelligent behavior, such as obstacle avoidance, tracking, and so on. The main advantages of this algorithm are:

1. The function of each behavior is relatively simple so that a better operation result can be obtained by a simple sensor and its rapid information processing process.
2. The high-level behavior is based on the lower-level behavior, but the lower-level behavior can be run separately or at the same time.
3. The behavioral layer can be increased, decreased, moved, and replaced without affecting other behaviors. It has a functional inheritance from top to bottom and good real-time performance.

**Behavior-based fuzzy control algorithm**

The motion environment of basketball robots is complex and, in most cases, unknown, so it is difficult to establish accurate mathematical models to predict or describe the position information of obstacles. Therefore, the fuzzy logic control algorithm is very suitable for the navigation and obstacle avoidance of basketball robots.

The fuzzy logic algorithm is based on an observational study of the driver’s work process. The driver’s collision avoidance action is not completed by accurately calculating
the environmental information, but according to the fuzzy environmental information, the planned information is obtained by looking up the table to complete the partial path planning. The advantage is that it overcomes the local extreme selection problem easily generated by the artificial potential field method, and shows great advantages for dealing with the planning problem in the unknown environment, and is very suitable for the navigation of the basketball robot in the unknown environment.

Basketball robots use ultrasonic sensors to obtain outside information. After the information is processed, it is used to control the change of the speed of the two wheels to determine the corresponding motion of the robot. This is a description of the general algorithm for basketball robots to walk around obstacles. In order to make the basketball robot move around the obstacle, the sensor needs to be arranged on the right front side, the front side, and the left front side. In order to prevent the distance measurement of the ultrasonic sensor from being measured due to specular reflection or other influences, two ultrasonic sensors can be installed in each group, and the smaller value in each group is taken as the distance value of the position. The perceptron information for various behaviors comes from the ranging data of three sets of ultrasonic sensors arranged on the vehicle body. The input of the fuzzy controller is the distance information of the sonar sensor and the direction information of the target. The output variable is the speed $v_l$ and $v_r$ of the two wheels as the output of the system, that is, the fuzzy control system with three inputs and two outputs is adopted; the structure diagram is shown in Figure 5.

1. Fuzzy description of input and output

Considering the environment in which the basketball robot is located, the input amount is the basketball robot distance obstacle information and the distance target position information, and the output is the traveling speed and steering angle of the basketball robot.

According to the position of the sensor distribution in the above section, the obstacles are divided into three categories: left, middle, and right. According to the distance of the obstacle, the domain of the obstacle distance is divided into $\{LNear, LMiddle, LFar, CFar, CMiddle, CNear, RNear, Rmiddle, Rfar, none\}$. Where L, C, and R represent the left, middle, and right, respectively, and none represents the obstacle-free object. The data measured by the sensor are quantized into the interval $[-15, 15]$, and the membership function is shown in Figure 6(a). The target orientation dire goal domain is divided into $\{LGoal, CGoal, RGoal\}$, and its membership function is shown in Figure 6(b). Since the target position is determined, the position coordinates do not need to be blurred. The linear velocity $v$ domain of the output variable basketball robot is divided into $\{SV, MV, VV\}$ ($S$, $M$, and $V$ represent slow, medium, and fast), the value range is $[0, 1]$, and its membership function as shown in Figure 6(c). The output variable robot steering angle domain is divided into $\{LVAngle, LMAngle, CAngle, RMAngle, RVAngle\}$, respectively, which are represented as left turn large angle, left turn small angle, no turn, right turn small angle, right turn big angle. The range of values is $[-90, 90]$, negative to the left, positive to the right. Figure 6(d) shows the angular velocity membership function.

2. Establishment of fuzzy rules

The establishment of fuzzy control rules is the core problem of fuzzy control. It is reasonable and effective to combine the principles of establishing fuzzy control rules with the experience of manual driving to develop fuzzy rule algorithms. The basic idea of making rules is to perform the trend toward the target when the obstacle is far away, and the target direction input plays a major role. When the obstacle is relatively close, the obstacle avoidance policy should be made according to the position of the obstacle and the target’s orientation, while the decision should be made as close as possible to the target’s direction. The factors affecting the basketball robot’s tendency to target behavior are mainly the information and target orientation of the obstacles in front and turn according to the target orientation information. The factors affecting the obstacle avoidance behavior of basketball robots are mainly the left and right obstacle distance information. When the robot is closer to the left (right) side of the obstacle, it turns to the
right (left). When it is closer to the front, it is prescribed first. Turn right and continue to judge the left and right distance of the obstacle. Only some of the fuzzy rules that have been developed are listed below, as given in Table 1.

3. Unambiguous

The result obtained by fuzzy inference is a fuzzy set, but in practice, there must be a certain value to control or drive the actuator. The process of transforming the fuzzy inference result into an exact value is called unambiguous. There are generally five kinds of de-fuzzing algorithms. This article uses the area center method, which is the most reasonable and most commonly used algorithm for all unambiguous algorithms. The amount of blur is converted into a clear amount and then linearly scaled to the actual control amount input to the actuator to realize the movement and steering of the basketball robot.

### Results and discussion

#### Path planning test of U-shaped obstacles

In order to verify the validity and reliability of the proposed algorithm, the path planning of the basketball robot was simulated. The first study is about the typical U-shaped obstacle environment, which has been extensively studied in robot path planning due to deadlock problems. This is a typical “symmetric indecision” phenomenon.25

Figure 7 shows the simulation results in a U-shaped obstacle environment. It can be seen from the simulation results that in the initial S → A phase, the robot quickly moves to the target point, and an approximate straight path is planned. This is because the target motion information is mainly affected by the robot motion. In the A → B → C → D phase, the U-shaped obstacle has a great influence on the robot. The robot mainly avoids obstacles and walks along the wall, and the moving speed is small. At the A and B points, there are obstacles in front of the robot. In the obstacle avoidance behavior, in the A → B, B → C, and C → D phases, the robot mainly walks along the wall and

| The number of rule | Dis-Obstacle | Dire-Goal | V  | Angle  |
|--------------------|--------------|-----------|----|--------|
| 1                  | L-Far        | L-Goal    | V-Velocity | LM-Angle |
| 2                  | L-Middle     | L-Goal    | M-Velocity | C-Angle  |
| 3                  | L-Near       | L-Goal    | S-Velocity | RM-Angle |
| 4                  | R-Near       | L-Goal    | S-Velocity | LV-Angle |
| 5                  | R-Middle     | L-Goal    | M-Velocity | LM-Angle |
| 6                  | R-Far        | L-Goal    | V-Velocity | LM-Angle |
| 7                  | L-Near       | CG-Goal   | S-Velocity | RM-Angle |
| 8                  | C-Middle     | CG-Goal   | S-Velocity | RM-Angle |
| 9                  | R-Near       | CG-Goal   | S-Velocity | LM-Angle |
successfully jumps out of the U-shaped deadlock. In the D → G phase, the robot again gets rid of the obstacles, quickly moves to the target point G, and plans a smooth path. It can be seen that the proposed algorithm can overcome the interference of U-shaped obstacles and reasonably plan a smooth path, which verifies the validity and reliability of the proposed algorithm.

Path planning test using different algorithms on the basketball court

In order to verify the feasibility and effectiveness of the proposed path planning strategy algorithm, the following experiments were designed. Design the fuzzy controller in Matlab, set the maximum moving speed of the basketball robot to 150 m/s, the obstacle map is randomly generated, the starting point and the ending position can be arbitrarily set, and the obstacle size, shape, and quantity can be set arbitrarily. However, for the convenience of calculation in the simulation process, round and rectangular obstacles are used.

On the simulation platform, the trajectory curve of the basketball robot moving from the current pose S to the given target point G is simulated. Figures 8, 9, and 10, respectively, show the trajectory diagram of controlling the basketball robot to reach the target point by using the literature11,12 and the algorithm of the present invention.

It can be seen from Figures 8, 9, and 10 that all three control algorithms can complete a given task within a certain simulation period, but the trajectory curve obtained by the algorithm proposed in this article is smooth and smooth. The trajectory curvature of the algorithm11 and the literature12 is sharply changed, and the smoothness is relatively poor.

To further verify the effectiveness of the proposed algorithm, three control algorithms are used to control the position error curve and the distance error curve of the robot reaching the target point. The simulation results are shown in Figures 11 and 12. It can be seen from the figure that the three control algorithms can effectively reduce the position error Ex, Ey and the distance error d. The robots controlled by the literature11,12 showed significant fluctuations in the left and right direction, and slight fluctuations in the up and down direction. However, the proposed algorithm to control the position error and the distance error of the robot target point are the smallest, which can show that the robot controlled by the algorithm is relatively stable and smooth, and the effectiveness of the proposed algorithm can be further verified.

Conclusion

To solve the problem of basketball robot path planning in a dynamic environment, an algorithm of basketball robot path planning based on fuzzy control is proposed. Fuzzy
logic reasoning is applied to the behavior control of the basketball robot. The distance information and target orientation information of the obstacle are taken as the input of the controller, and the linear velocity and angular velocity of the robot are taken as the output of the control system. The fuzzy control algorithm based on behavior classification can avoid collision effectively and reach the destination smoothly. The fuzzy control algorithm is adopted to control the driving speed of the basketball robot, which can improve the movement ability and safety. Simulation results show that the algorithm is feasible and has good capability of path planning. The fuzzy control algorithm avoids the disadvantages of the traditional algorithm, such as being sensitive to the positioning accuracy of the basketball robot and being highly dependent on the information of the environment, effectively solves the obstacle avoidance and navigation problems, and realizes real-time path planning and control. Although this article can effectively solve obstacle avoidance and navigation problems and realize real-time path planning and control, it consumes a lot of time. Therefore, our next work is to improve the time efficiency on the basis of ensuring the accuracy of path planning.

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