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Design of an Intelligent Robot with Anti-interference

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Abstract: *In this paper, a dual photoelectric anti-interference intelligent robot with PID control principle is designed based on the application requirements of intelligent patrolling robot. The robot system is mainly composed of three parts: the controller module, the motor drive module, and the photoelectric sensor module. The controller accurately controls the drive motor power with the PID algorithm by processing the analog signals collected by the two photoelectric sensors, so as to realize the curved and straight line driving. In the case of external light interference, it can still adapt well to the ambient light without leaving the guide line.*

Keywords: *PID control, intelligent robots, anti-interference*

1. Introduction

With the change and development of robotics industry, mobile robots have become an important field of competition among countries all over the world[1,2]. Robot localization and navigation technology is one of the most core technologies and has been widely studied. Emerging intelligent robot localization and navigation technologies include GPS navigation technology, UWB (Ultra-Wide Band) technology, SLAM (Simultaneous Localization And Mapping) technology and so on. Among them, GPS navigation can be used almost anywhere outdoors and is widely used in our life, but it cannot be used indoors due to its weak electromagnetic wave penetration ability[3,4].UWB ultra-wideband technology, a low-power short-range wireless transmission technology, has a very wide range of communication frequencies (from 3.1 GHz to 10.6 GHz), and transmits signals that are short, with pulse widths of nanoseconds, and propagate in indoor environments that can penetrate walls and walls. indoor environment propagation can penetrate walls and obstacles, so it is widely used in indoor positioning technology[5]. However, it has been criticized for its high cost of use due to its attached localization base station[6]. SLAM technology is mainly used in unknown environments, where robots autonomously construct indoor environment maps to help robots realize autonomous walking. According to the different sensors used to obtain environmental information, it can be categorized into laser SLAM (Lidar-SLAM) and vision SLAM (VSLAM)[7]. Lidar-SLAM is also very expensive, while visual SLAM cannot be used in scenes with changing ambient light or dim indoor conditions.

In fixed places with known environments, such as factories and restaurants, more and more robots are realizing localization and navigation by means of guide lines laid on the floor. Although this scheme has the advantages of simple implementation and low project cost, the photoelectric sensors are highly susceptible to the interference of external light in the process of using. In this paper, we improve the stability of the system by building a simple model cart and adding a new photoelectric sensor to detect changes in the external light in order to correct the parameters related to the roving track.

2. System operation principle and design

The system is mainly composed of three parts: the controller module, the motor drive module, and the photoelectric sensor module. The controller processes the analog signals collected by the two photoelectric sensors, and accurately controls the drive motor power with a PID algorithm, so as to realize the curved and straight line driving. The two photoelectric sensors are placed side by side but spaced at a certain distance horizontally. p1 is above the black and white junction position and p2 is always above the white area. A large amount of experimental data is obtained in different lighting environments to fit a functional relationship between the P2 detection value and the P1 threshold, and then provide a threshold modification reference for the trolley during its operation.

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2.1. Hardware design

The trolley consists of an E3 controller provided by Guangzhou Zhongming Digital, two drive motors, two photoelectric sensors (JMP-BE-1125) and some plug-in parts. The left motor is connected to the controller M3 port, the right motor is connected to the controller M1 port; the left photoelectric sensor is connected to the controller P1 port, the right photoelectric sensor is connected to the controller P2 port. The sensor is shown in Fig. 1, and the construction is shown in Fig. 2.

Figure 1: Photoelectric sensors.

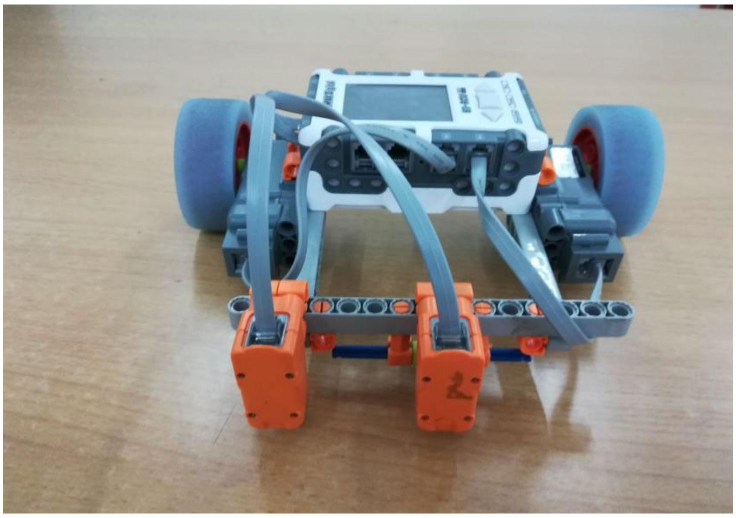

Figure 2: Intelligent Trail Robot.

2.2. Program Design

Since the sensor P2 only gives reference to the threshold modification of P1, the program is algorithmically divided into two parts: P1 sensor detection and motor control, P2 sensor detection and threshold modification for design.

2.2.1. P1 Sensor Detection and Motor Control

After testing the value of the photoelectric sensor P1, the value of its indoor white area is about 2700 mV and the value of the black area is about 700 mV when the direct sunlight is stronger. Setting the sensor threshold variable named *fazhi*, so that the initial value of *fazhi* = 1700 mV. normal operation, P1 is at the right edge of the black line position, when the measured value of P1 is greater than the *fazhi*, it can be considered that the cart attitude skewed to the right, and vice versa, it is considered that the skew to the left, and according to the degree of skewing corresponds to a different amount of control, so as to realize the scientific proportionality (P) control. Through the parameter transfer, it can judge whether the deflection amount is smaller or bigger, so as to realize the prediction and processing of the adjustment trend and differential (D) control. Since the trolley movement process is a dynamic

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adjustment process, so the integral (I) in the use of the significance of this place, so the system is used in the PD (Proportional Differential) control. the graphical program of the PD control is shown in Figure 3.

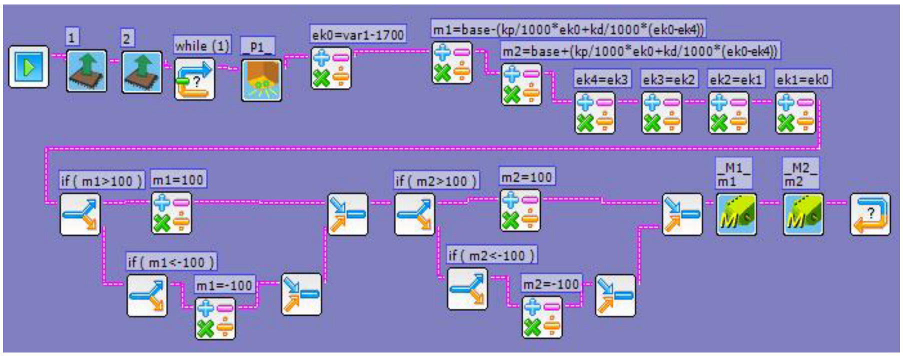

Figure 3: Graphical programming diagram for PD control.

PD control C program code:

Begin

While(1){

*m1=base-(kp/1000*ek0+kd/1000*(ek0-ek4));*

*m2=base+(kp/1000*ek0+kd/1000*(ek0-ek4));*

ek0=var1-1700;

ek4=ek3;

ek3=ek2;

ek2=ek1;

ek1=ek0;}

End

Where *base* is the initial value of power; *var1* is the value detected by the P1 sensor, *m1* and *m2* are the power values of the motor respectively. *Kp* and *Kd* are the proportional and differential values, respectively; *ek0*, *ek1*, *ek2*, *ek3*, and *ek4* are the current deviation value (denoted as the *K*th), the (k-1)th deviation value, the (k-2)th deviation value, the (k-3)th deviation value, and the (k-4)th deviation value, respectively.

To limit the calculation results in order to have all values lie within the interval (-100, 100), since some of the operational data may be outside the motor power range.

C program code of Limit :

Begin

if(m1>100) m1=100;

else if (m1<-100)m1=-100;

if(m2>100) m2=100;

else if (m2<-100) m2=-100;

End

2.2.2. P2 Sensor Detection and Threshold Modification

Through experiments, it is found that P1 and P2 have different white and black values in different light environments. For example, in direct sunlight, the photoelectric sensor detects the value regardless of black and white, and the photodiode is in the state of photocurrent saturation, which can not realize the difference between black and white. Although this paper explores the system anti-interference, but can not be used in direct sunlight serious environment. After comparing a large number of photoelectric sensor statistics and fitting the data through Origin, the functional relationship between the P2 ambient

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value and the P1 threshold in the case of non-severe direct sunlight is derived.The results of the data fitting are shown in Figure 4 and Figure 5.

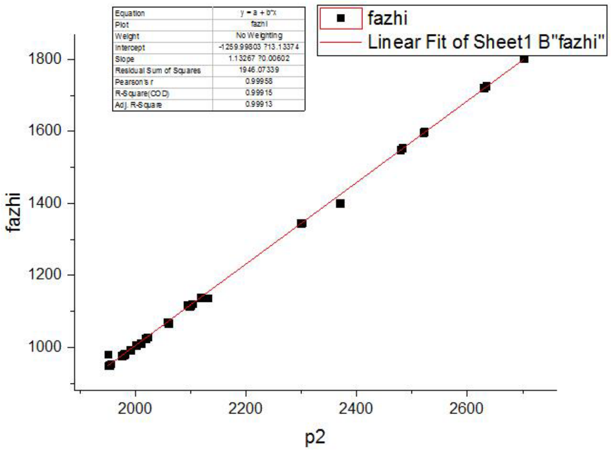

Figure 4: Plot of fazhi and P2 data fitting results.

		Value	Standard Error	t-Value	Prob>|t|
fazhi	Intercept	-1259.99803	13.13374	-95.93596	0
	Slope	1.13267	0.00602	188.15318	0

Slope is significantly different from zero (See ANOVA Table).
Standard Error was scaled with square root of reduced Chi-Sqr.

Statistics

	fazhi
Number of Points	32
Degrees of Freedom	30
Residual Sum of Squares	1946.07339
Pearson's r	0.99958
R-Square(COD)	0.99915
Adj. R-Square	0.99913

Summary

	Intercept		Slope		Statistics
	Value	Standard Error	Value	Standard Error	Adj. R-Square
fazhi	-1259.99803	13.13374	1.13267	0.00602	0.99913

Figure 5: Data fitting results.

The fitting results generated by this software, ignoring the effect of chance error, can be approximated as a linearly varying relationship between the P2 measurements and the P1 threshold (Standard Error 0.006, R-square 99.91%, slope value = 1.13267, intercept value = -1259.99803).

In order to prevent the influence of misjudgment or ground impurities on the detection of mutations, add the weights filter function:

Begin

*fazhi=1.13*p2-1260;*

*fazhi1=6/10*fazhi+4/10*fazhi0;*

fazhi0=fazhi;

End

The final graphical programming diagram and intelligent cart operation diagram are shown in Figures 6 and 7.

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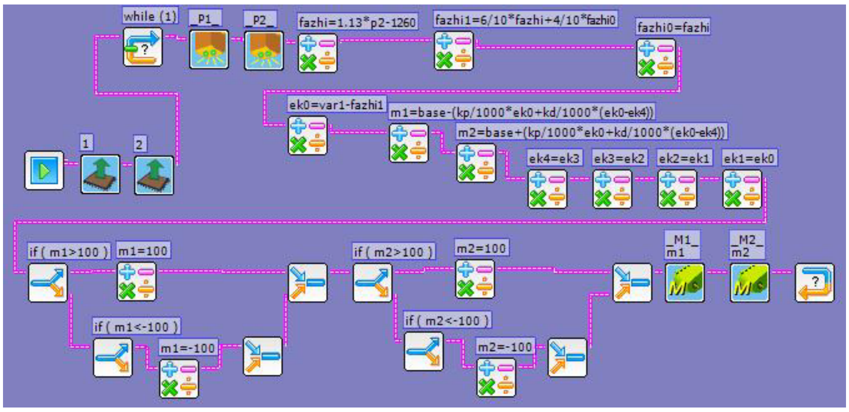

Figure 6: graphical programming diagram.

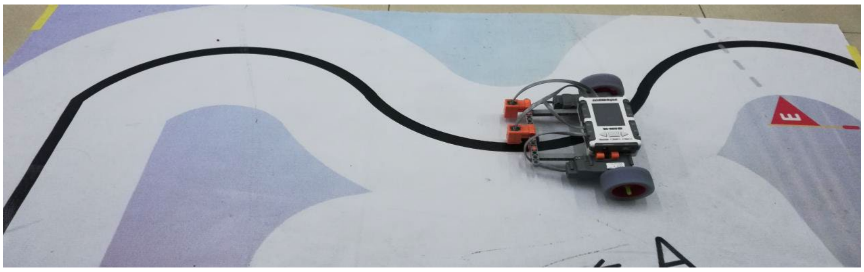

Figure 7: Intelligent Robot Operation Diagram.

3. Conclusions

It has been proved that this system can well realize the function of anti-environmental light interference of intelligent trolley, and at the same time, in the case of not too fast speed, using digital filtering means to shield off the ground unevenness and other interferences, it can well realize the function of anti-interference patrolling.

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