RESOURCE ALLOCATION NETWORK AND PID CONTROL BASED ON AUTOMATED GUIDED VEHICLES

Qizhi Wang\textsuperscript{1}, Xiaoxia Wang\textsuperscript{2}, Bingyang Sun\textsuperscript{3}

\textsuperscript{1}College of Mechanical Engineering and Automation, Huaqiao University; Key Laboratory of Process Monitoring and System Optimization for Mechanical and Electrical Equipment in Fujian Province University, Huaqiao University, Xiamen, 361021, China

\textsuperscript{2}College of Computer Science & Technology, Huaqiao University, Xiamen, 361021, China

\textsuperscript{3}College of Mechanical Engineering and Automation, Huaqiao University, Xiamen, 361021, China

Email: wangqz@hqu.edu.cn

ABSTRACT: Automated Guided Vehicles (AGV) are used more and more in modern industrial production and logistics. In the traditional guiding method, the AGV mainly adopts the magnetic guiding mode, and the obtained deviation information is single, and the control effect is poor, so that the operation of the AGV is easy to cause the left and right shaking phenomenon, thereby causing the AGV to derail. In the actual factory floor operation, the traditional PID (Proportional Integral Derivative) controller control technology is difficult to meet the complex trajectory tracking requirements of AGV. Therefore, the research on the path recognition of AGV and its trajectory tracking control has extremely important application value. The core of AGV car motion control is to control servo drive motor to achieve speed tracking. In this paper, PID parameters are adjusted by RAN algorithm. The simulation results show that the method has high performance, good tracking ability and high approximation precision.

KEYWORDS: Automated Guided Vehicles, PID, Resource Allocation Network

1. INTRODUCTION

Automated Guided Vehicles (AGV), also known as unmanned vans, appeared in the 1950s and is an automated, unmanned, intelligent handling device that is a mobile robotic system that can be pre-set. It belongs to a mobile robot system and can travel along a predetermined path. It embodies the advanced technology of sensor technology, mechanical and electronic engineering, computer engineering, control engineering and artificial intelligence, and represents the electromechanical integration. Its system technology and products have become flexible production lines, flexible assembly lines, and warehousing. The important equipment and technology of the logistics automation system is one of the most active areas of scientific and technological development. (Yongsheng Yang et al (2018), Mingyao Qi et al (2018), Johannes Schmidt et al (2015), Xiumin Fan et al (2015), Toshiyuki Miyamoto (2016), Radhia Zaghdoud (2016), Rundong Yan, (2018), Waldemar Maopolski (2018), Andor Bálint Viharos (2018).

Social issues – population ageing and labor shortages – these two major social problems are subject to tremendous pressure in the future for industries that require large amounts of labor. Therefore, it also forces the manufacturing industry to upgrade and upgrade. It requires not only the use of advanced manufacturing equipment, but also the transformation of current production and development strategies so that it can survive in a fiercely competitive environment and at the same time further promote manufacturing.
The transformation and development of the industry. In order to save costs and shorten the production cycle of the product, advanced technologies such as Flexible Manufacture System (FMS) and factory automation have been gradually developed. Industrial robots, intelligent automated warehouses, unmanned vehicles, material sorting equipment such as identification systems are widely used in flexible manufacturing systems and factory intelligent automated production processes. Among them, the content of the unmanned van is mainly marked by the automatic guided trolley. In the manufacturing workshop of the enterprise, in order to develop the modern logistics system, the information and materials required for production in the production process can be unified, the use of AGV is essential, and the use of AGV can reduce labor-intensive enterprises. The degree of dependence on resources further reduces the labor intensity of employees, and the industrial production efficiency of enterprises is greatly improved, and the level of enterprise benefits is maximized. In the industrial production operation, the large amount of AGV put into use can make the current problems in the society—labor shortages be compensated, which has played a positive role in the industrial upgrading of modern manufacturing industry. V. K. Chawla (2018), Dimitri Antakly (2017), Jens Heger (2018), Hee-Woon Cheong (2018)

The automatic navigation vehicle is generally used in the logistics system of the workshop, and its load capacity is large. In order to improve the production efficiency, the operation speed can be improved, and the workshop with limited space must overcome the personnel and the speed of the AGV. Equipment safety issues, there is an urgent need to improve the accuracy of AGV at high speed to improve this problem. Traditional tracking precision control usually adopts pure PID control algorithm or improved PID control algorithm. Although these algorithms improve the tracking accuracy problem, it relies on accurate vehicle control mathematical model, which is very engineering. Difficult to achieve high accuracy, so it still can not meet the needs of the logistics system of the current efficient production workshop. The successful application of the adaptive fuzzy PID control system and other control systems allows us to see the dawn of improving the accuracy of high-speed AGV tracing systems.

2. ADVANTAGES OF AGV

In recent years, AGV robots have been rapidly developed and promoted, which not only meets the needs of the rapid development of modern industries, but also plays an important role in improving production efficiency. The rapid development of AGV robots is mainly due to the following advantages of AGV itself: Grzegorz Kosowski (2018), Maria Pia Fanti (2018), Hee-Woon Cheong (2018), Fabjan Kallasi (2017), Puneeth Valmiki (2018)

(1) High adaptability and high flexibility

AGV robots can be easily connected to other logistics equipment, such as various conveyor lines, material transfer stations, elevators, automatic accumulation chains and robots, etc., which can track, record and inspect materials for production lines and inventory management systems. Provide real-time logistics information

(2) High reliability

Compared with human beings, AGV robots are not affected by the external environment, and human work is often affected by work intensity and psychological factors, resulting in inefficient work and error. The use of AGV robots can greatly improve the accuracy and reliability of your work. Even if there is a fault that requires repair, the work
of other AGV robots will not be affected, thus ensuring that the entire system can work properly.

(3) High work efficiency

The use of AGV robots greatly reduces the labor intensity of workers, and operators do not need to perform a large amount of reporting work for tracking materials. Take the Amazon Tracy Logistics Center as an example. Before the AGV robot is used, the average worker picks from the shipment to the delivery.

(4) High degree of intelligence

AGV robot integrates modern and latest technologies such as automatic navigation technology, image recognition technology, wireless communication technology, information acquisition and processing, servo drive and control, intelligent obstacle avoidance, speech recognition, deep learning, etc., greatly improving the intelligence level of AGV robots. At the same time, it has also broadened the scope of use of AGV robots, such as the catering industry and the domestic industry. AGV robots have also begun to appear.

(5) Ability to adapt to special circumstances

In the military field, AGV robots are also widely used, mainly through the installation of detection and disassembly equipment on the AGV, and the demining and position reconnaissance work on the battlefield. The use of AGVs to transport cargo at nuclear power plants or sites with nuclear radiation greatly reduces the risk of radiation. In addition, in the dark workplaces such as film and film warehouses, AGV can be used to accurately and reliably transport materials and semi-finished products.

3. ANALYSIS OF KEY TECHNOLOGIES OF AGV

3.1 Guidance technology

Guidance technology has always been a core part of AGV technology research. The quality of guidance technology is directly related to the accuracy and performance stability of AGV. It also determines the key factors such as AGV functionality, application practicability, and automation. Affects the functional reliability of the entire AGV system operation. Patric Beinschob (2017), Patric Beinschob (2017), Huarong Zheng (2017), G.Bocewicz(2017), Elena Cardarelli (2017)

(1) Wire Guidance

Electromagnetic guidance is the most advanced and most mature guidance method for AGV. The guiding method is to use the principle of electromagnetic induction to conduct the guiding current of the buried metal wire at a certain frequency, and realize the guiding of the AGV by identifying the guiding frequency. Through the detection of the left and right electromagnetic sensors on the AGV, the strength of the magnetic field is detected and the driving direction of the AGV trolley is controlled according to a certain law. The disadvantage is that it also needs to be equipped with additional equipment capable of generating electromagnetic signals; the navigation line is laid once, and subsequent changes require secondary operations. Compared with laser navigation, the cost and time of modifying the line later increase; and the pavement also has some damage to the road surface during the laying process. The construction requirements are strict to restore the aesthetic requirements of the ground.

(2) Magnetic Guidance

Magnetic guidance is similar to electromagnetic induction guidance. The difference is that this method is to lay the surface magnetic strip on the running route, and the magnetic navigation sensor traces the surface magnetic strip to induce the magnetic signal. A micro-Hall sensor on the magnetic navigation sensor corresponds to a detection point respectively. The most important thing is the high accuracy of magnetic stripe navigation measurement and its good repeatability. It has high reliability and stability during operation, low maintenance cost and long service life. The disadvantage is that the magnetic strip is easily damaged and the overall aesthetics of the pavement is reduced by the laying of the magnetic strip. Since the AGV turns to crush the magnetic strip, some of the magnetic strips need to be cut off, thus causing the magnetic strips to be inconsistent. Magnetic strips can cause magnetic changes due to the
attraction of metallic substances, and can also cause malfunction of AGV equipment.

(3) Laser Navigation
Laser guidance does not require an advanced guidance method for handling the ground in advance, but it needs to be installed on the AGV car to emit and receive laser devices, and through the operation area around the installation of high reflective reflector plate, as a positioning sign. The working principle is that the receiver collects the signal emitted by the reflector plate, and obtains the accurate position and movement direction of the current vehicle through a series of geometric calculations, so as to facilitate the correction of the running direction. The utility model has the advantages that the positioning precision is high, the ground does not need other positioning auxiliary devices, the running path can be changed at will, and can be applied to various environments, and is a relatively advanced navigation method at present. The disadvantage is high cost and high requirements on the operating environment.

(4) Optical Guidance
Optical guidance is to change the magnetic stripe in the magnetic guide into paint or ribbon, and the magnetic navigation sensor is replaced by an optical sensor. The working principle is the color path information collected, and then the computer can easily identify and analyze the color signal of the image. Implementation guidance. The advantages are that it is flexible, easy to change. The disadvantage is that it is very sensitive to mechanical damage and is greatly affected by ground conditions. Once the ribbon is contaminated to a certain extent, the reliability of the guidance is deteriorated and the accuracy is also low.

(5) Ranging navigation
This navigation method mainly uses the laser two-bit scanner to scan and measure the surrounding environment. After acquiring the measurement data, the navigation algorithm is used to realize the tracking function. The navigation sensor is usually implemented by a laser scanner with safety function. The safety laser scanner can not only realize the safety function, but also realize the navigation measurement function.

(6) Contour navigation
Contour navigation is the most advanced navigation method at present. This technology uses the laser scanner to measure and learn the scene environment, draw the navigation environment, and then realize the contour navigation function through the map correction method, using the natural environment (Free-range navigation for walls, pillars, etc., and update the position based on environmental measurements).

3.2 Positioning Technology
The positioning technology directly determines the reliability and functionality of the AGV. Positioning means that the external information is sensed by the sensor and the effective control of the main controller determines the position of the controlled device in the field layout. The positioning technology can control the position of the AGV in the path and accurately deliver the corresponding task through the position information. According to the type of signal, there are GPS positioning, beacon positioning, inertial positioning. It is necessary to periodically correct the accumulated positioning error to improve the accuracy.

3.3 Intelligent Control Technology
From the beginning of the 20th century, control theory has evolved and evolved. With the modern control theory constantly integrated into new discipline technologies, such as fuzzy mathematics, neural networks, etc., the traditional control technology has gradually developed into a better solution to complex system control problems. Intelligent controls are human-like intelligences, with functions such as self-learning, speculation, and decision-making. They can make effective guesses and decisions based on changes in control objects or control environments without human intervention or help.

Intelligent control is an inevitable trend in the development of control theory. It is obviously superior to traditional control methods in depth and
breadth. It is the mutual penetration of computer science technology, information technology and other subject knowledge, and the continuous development of control science and engineering research. The AGV system has the characteristics of uncertainty, complexity and nonlinearity in the motion control model and the dynamic control model, and the intelligent control just can achieve good control. The current control methods applied to AGV are fuzzy control, neural network control, genetic algorithm control, pattern recognition control, etc., and the former two applications are more.

4. INTELLIGENT VEHICLE PATH IDENTIFICATION AND PID CONTROL SYSTEM

The path tracking technology of the smart car is similar to the path tracking technology of the robot, but the tracking object of the smart car is not as complex as that of the intelligent robot, but the cooperation between the driving speed and the driving direction is stricter. First, the target road information is obtained through the sensor, and then in combination with the current driving state of the smart car, the decision is made intelligently, and the driving direction and the driving speed are adjusted to achieve the purpose of accurately and quickly tracking the road.

According to the completeness of road information, path tracking signs and other factors, the path tracking technology of smart cars is mainly divided into machine vision based path tracking, map based path tracking, special road sign based path tracking based path tracking.

In the research of path tracking control of AGV, PID controller is a classic controller that we often use nowadays. It is widely used in the actual control process because of its simple structure and easy to debug parameters. At present, many scholars have done a lot of research on improving the precision of PID control.

![Fig.2 Kinematics coordinates system of AGV car](image)

In the online self-tuning optimization of PID parameters, a lot of research work has been devoted to the research of parameter optimization, such as the fuzzy, neural network, etc. The intelligent optimization algorithm is applied to the PID parameter tuning to improve the tuning effect and control accuracy.

5. APPLICATION ANALYSIS OF RAN-PID ALGORITHM

The resource allocation network (RAN) main idea is that when the neural network finds "non modeled" samples in the learning process, new compute nodes are allocated. The network has the local feature that each of the hidden nodes in the network responds only to the local area of the input space (G. Bocewicz, 2017, Elena Cardarelli, 2017)

Algorithm Implementation is

(1) Initialization: there is no hidden node in the network; let $\gamma = T_0$ (from the first sample), resolution $\delta = \delta_{\text{max}}$

(2) Input samples is $(I, T)$, it calculate the current network output $y = \sum_j h_j x_j(I) + \gamma$

Calculation error is $E = T - y$

(3) Find the nearest data center $d = \min_j \|c_j - I\|

(4) If the distance criterion and the error criterion are satisfied, $\|E\| > \varepsilon$ and $d > \delta$, the new hidden nodes are allocated: $c_{\text{new}} = I, h_{\text{new}} = E, w_{\text{new}} = \sigma d$
(first times the hidden nodes are allocated, \(w_{new} = \sigma \Delta\)), or transferred to the step (6).

(5) If a continuous step \(r_{i,k}\) is less than the set threshold \(\delta\), the corresponding hidden layer node will be deleted.

(6) Adjust \(r, h_j, c_j\) by the gradient method and make the error \(\|E\| < \varepsilon\).

(7) If, \(\delta > \delta_{\text{min}}\) then \(\delta = \delta \times \gamma\), to step (6)

The AGV autonomous mobile robot can sense its position through the sensor and continuously correct the trajectory error to achieve. The purpose of the trace. The AGV autonomous mobile robot in the background of this paper is based on the visual sensor, calculates the position deviation of the front line by continuously collecting the front path information, and gives the control amount of the chassis speed according to the PID control principle, and finally achieves the tracking purpose.

The chassis adopts two-wheel differential steering design, that is, the mobile robot is realized by controlling the different speeds of the two driving wheels of the chassis. In the tracking process of the AGV mobile robot, what is actually needed to control is the position of the mobile robot relative to the guide line. It is desirable for the AGV mobile robot to be in its central symmetry line throughout the operation of the AGV mobile robot. The position of the AGV vision system relative to the guide line is used as the deviation of the RAN-PID control input, and the speed increment of each round of each control cycle is calculated by the incremental PID control algorithm, and then the cycle continues to reach the final AGV mobile robot. The purpose of tracking. The controlled object is \(\frac{0.63 \times 10^7}{s^2 + 350s + 4.35 \times 10^5}\). The control process is shown in Figure 3.

![Fig.3 Simulation results of motor RAN-PID angular velocity tracking](image)
Figure 3 shows the results of motor RAN-PID angular velocity tracking. Figure 4 is the simulation results of unit sinusoidal angular velocity tracking error of incremental PID motor. It reached the stable time shortly and it has only small error.

6. CONCLUDING REMARKS

In this paper, the control algorithm of intelligent car is studied theoretically based on the model of intelligent car. At the same time, the intelligent car model is designed, and the control algorithm is simulated by the intelligent car, which verifies the control effect and performance of the control algorithm. In this paper, an RAN+PID scheme is developed to achieve good tracking. The steady-state control accuracy can be guaranteed by control algorithm. Simulation examples have illustrated that high performance and good tracking with respect to RAN neural PID control system.

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