Research on Water Pollution Control Based on STM32 Intelligent Vehicle

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Abstract: In order to solve the high cost and low efficiency of different degrees of pollution control of natural water resources in China at this stage, photocatalytic water purification technology is adopted to reduce the cost of water pollution treatment and improve the treatment efficiency, and an intelligent vehicle equipped with photocatalytic materials is proposed, which is equipped with industrial cameras, communication positioning modules and sensors, and realizes dynamic planning of navigation routes by improving ant colony algorithms, computer vision recognition, ultrasonic obstacle avoidance, and realizes photocatalytic fixed-point purification. Predict advanced photoelectric catalytic performance based on density functional theory and machine learning, solve the problem of BiVO4 photo corrosion and instability, and achieve efficient water purification at low cost.

Keywords: Water Pollution; Intelligent Vehicles; Photocatalysis; Ant Colony Algorithm; Exhibitable Institutions

1. Introduction

Cities are the main body of economic development and the spatial carrier of high-quality development. With the continuous progress of urbanization, the urban industrial and economic level has been developed rapidly, the urban supporting construction has been improved continuously, and the discharge of urban sewage has increased rapidly. The contradiction between the large amount of domestic industrial sewage discharge and the limited treatment capacity has become the main contradiction restricting the high-quality development of cities[1]. At the same time, the increase in population leads to the increase in the demand for agricultural products, the rapid development of livestock and poultry breeding and planting, and the corresponding increase in the discharge of agricultural waste and livestock and poultry manure in the process of agricultural production [2]. In addition, the pollution caused by the irrational use of pesticides and fertilizers increases the damage to the water environment [3]. It has bad influence on the protection of water ecological environment in high quality urban development.

At present, as a high energy consumption industry, sewage treatment plants need to consume a lot of energy while ensuring the prevention and control of water pollution[4], and the economic input, management level and operation cost of sewage treatment plants are also directly related to the economic benefits of sewage treatment plants. Clean water and green mountains are invaluable assets[5]. Under the policy of energy conservation, emission reduction and sustainable development, it is urgent to solve the problems of high cost and low efficiency of water pollution control[6]. Based on this, a water pollution control scheme based on intelligent vehicle and photoelectric catalytic materials is proposed[7].

2. Intelligent vehicle design

The intelligent vehicle developed based on STM32 is composed of environmental information acquisition module, autonomous control module, communication module, motion performance module and power supply module. The whole structure can realize automatic navigation.

2.1 Hardware system and comprehensive obstacle avoidance and path planning design

Based on STM32 main control by the power module, obstacle detection module, motor drive module, infrared remote control module composed of intelligent obstacle avoidance system. The HCSR04 ultrasonic sensor, HJIR2 infrared sensor and MMA7361L tilt sensor cooperate to form the obstacle detection part to complete the obstacle detection. The handheld infrared remote control and vehicle infrared receiver constitute the manual control part, and the L298P motor drive chip, HJIR6 photoelectric speed measurement module and electric motor constitute the driving part.

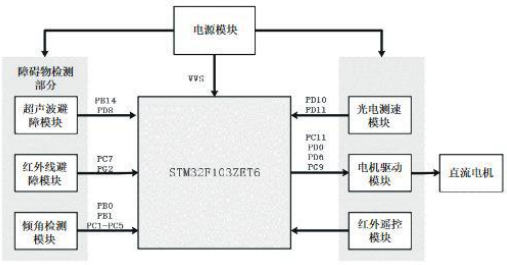

Figure 1 Hardware connection diagram

Compared with the traditional single infrared single ultrasonic obstacle avoidance and intelligent vehicle obstacle avoidance system, we use infrared - ultrasonic - Angle detection comprehensive obstacle avoidance system, infrared - ultrasonic can ensure the sensitivity of the detection of medium and short distance obstacles, to ensure that navigation instruments have enough space distance to avoid obstacles, as far as possible to reduce the probability of limiting obstacle avoidance. At the same time, considering the characteristics of surface navigation of the vehicle, an inclination detection device is added to monitor the inclination of the vehicle in real time to prevent rollover. Moreover, the detected inclination data can better guide the obstacle avoidance process and ensure the safety of surface navigation of the vehicle.

2.2 Improve ant colony algorithm path planning and design

At present, ant colony algorithm usually requires a long search time due to the lack of initial pheromones and the insignificant difference of heuristic values of adjacent grids, resulting in slow convergence[8]. When the grid model is complex, the vehicle may become deadlocked, unable to move into the surrounding grid[9]. In the grid diagram, traditionally shaped planes may have more bending times and large cumulative bending angles, so we make improvements to solve the above problems.

The improved ant colony algorithm introduces the estimation function of A* algorithm as a heuristic function:

$$f(n) = g(n) + h(n)$$

$$h(n) = [(n_x - g_x)^2 + (n_y - g_y)^2]^{1/2}$$

$$g(n) = [(n_x - s_x)^2 + (n_y - s_y)^2]^{1/2}$$

Improvements in convergence rate, shortest path length and bending suppression effect. The search efficiency and path smoothness are improved. The problem of ant deadlock is solved by introducing the shrinkage mechanism and the improved max-min ant system method, and the global search ability of the algorithm is improved. Three path planning algorithms in ordinary map, tunnel map, slot map and baffle map are studied respectively. The experimental results are as follows:

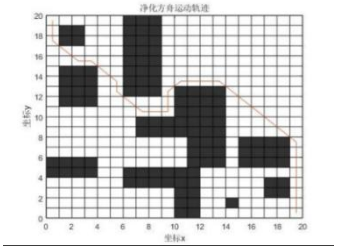

Figure 2 Simulation trajectory diagram based on ant colony algorithm

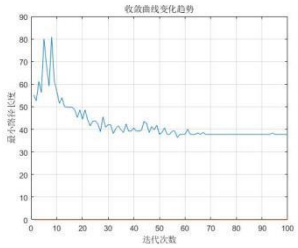

Figure 3 Minimum path variation diagram

Compared with the traditional ant colony algorithm and algorithm, the improved ant colony algorithm has better convergence speed and bending suppression effect. Compared with the traditional ant colony algorithm, the iteration times of the improved ant colony algorithm are reduced by more than 65%, and the bending inhibition is reduced by 41%. In addition, the number of iterations of the improved ant colony algorithm is 54% lower than that of the previous algorithm. In conclusion, the effectiveness, rapidity and adaptability of improved ant colony algorithm in complex map environment provide a new idea and method for path planning optimization.

2.3 Design of photocatalytic fins

Photoelectrochemical corrosion of photoanode occurs in the degradation process of photocatalytic materials. Therefore, a folding mechanism based on Miura folding is designed. The space deployable mechanism has the advantage of large folding ratio and is often used in the development and recovery design of solar panels and antennas of space satellite aircraft. It is used in satellite, spacecraft solar panels, acoustic walls and other aspects. This device is the application of space deployable mechanism, which can realize large opening area and less space occupied by folding. A purified photocatalytic material is attached to it. By using the foldability and modularity of the wing plate, the light sensor receives information, determines the direct sunlight Angle, and adjusts the unfolding Angle to achieve high efficiency photocatalysis to the maximum extent[10].

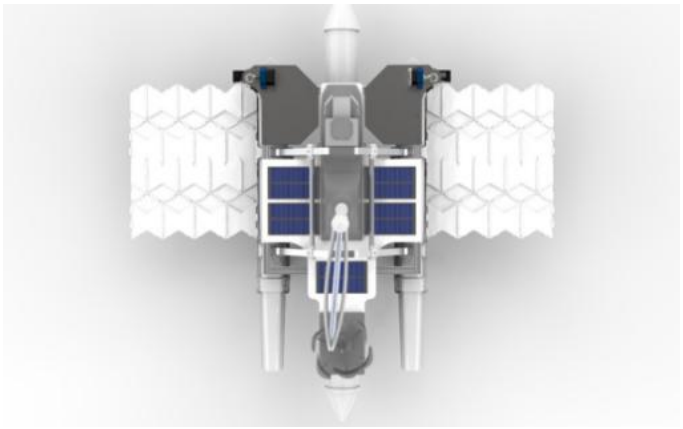

Figure 4 Simulation of the expansion of the wing plate

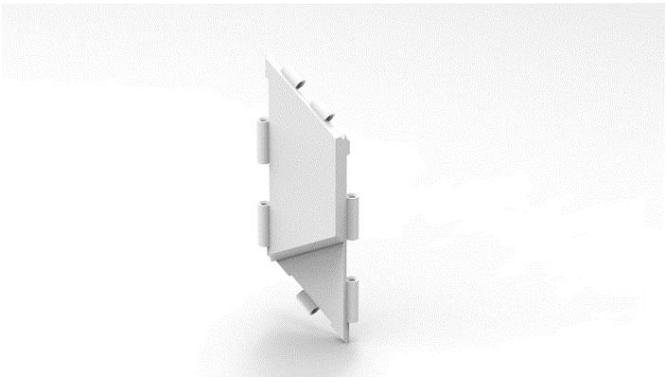

Figure 5 Wing panel unit design

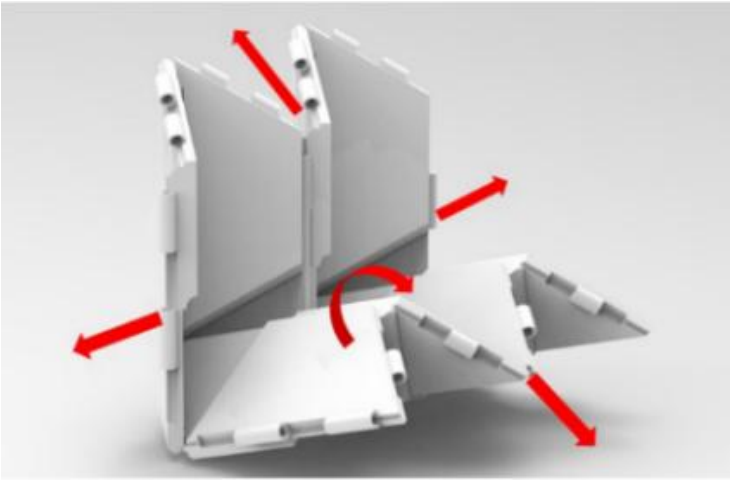

Figure 6 Analysis of the development direction of the wing plate

2.4 Bismuth vanadate photocatalytic material

BiVO4 Bismuth vanadate has been widely used in photoelectrocatalysis due to its excellent photoanode properties, showing remarkable catalytic efficiency. However, due to the self-oxidation/reduction of its metal ions by the photogenerated carrier of the semiconductor, photocorrosion is caused, which leads to the instability of the photoanode, and its V5+ ions are easy to fall off. In order to effectively utilize the high degradation efficiency of BiVO4 and modify the instability, the photocatalytic performance of BiVO4 with controllable defects was predicted based on first principles, and BiVO4 material was synthesized based on hydrothermal method.

3. Conclusion

1) With a high degree of automation, machine learning algorithm and improvement of software and hardware systems on the basis of energy conservation and emission reduction are used to achieve efficient purification of manufacturing, enterprises, industrial sewage ponds and sewage treatment plants at a low cost.

2) The direct sunlight Angle can be determined by the sunlight sensor and then the Angle of the wing plate can be adjusted to maximize the efficiency of photocatalysis, thus increasing the water purification efficiency by about 43.2%.

3) With modular nature, the foldable wing structure can be adapted to ship types in various scenarios, and can be applied to most of the domestic water pollution control environments.

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