ISSN: 2664-9640

Research on Intelligent Unmanned Food Delivery Truck Based on ROS

Lintao Xu

Qufu Normal University engineering college, Rizhao, Shandong, 276827, China

Abstract

Since the outbreak of the epidemic, epidemic prevention and quarantine has become one of the main means of epidemic prevention. In order to reduce the pressure of food supply in epidemic prevention and quarantine and solve the problem of food supply for quarantined personnel during the outbreak of the epidemic, an intelligent unmanned food delivery truck with lane identification and following, path planning and two-dimensional code recognition is designed. The food delivery truck adopts an industrial computer (CPU-I7/8G /256G) equipped with ROS system as the control center, adopts high-thread liDAR to realize the perception of the surrounding environment, and uses machine vision software library OpenCV to realize the lane line identification and following, and the most stable control under the most safe condition. Under the ROS distributed robot operating system, To achieve environmental map construction, path planning, autonomous navigation, data fusion with liDAR to ensure that the food delivery car to achieve human-computer interaction function block design. Differential four-wheel drive design is used in the chassis to improve control robustness.

Keywords

Perceptual intelligence; Mobile intelligence; TEB. Precise navigation.

1. Introduction

Artificial intelligence robots are widely used in the epidemic prevention field of sudden public health events, which has greatly promoted the development of national epidemic prevention and security. In view of the unmanned food delivery trucks that have already been launched, in the context of epidemic prevention and control and takeout industry, there are many practical problems in urgent need of food delivery.

This study choose multi-threaded laser radar with high resolution camera sensor fusion technology, to achieve intelligent perception, realize accurate navigation, path planning, can drive regional lane line identification, detection and pedestrian traffic lights, designed four-wheel differential drive mobile intelligence, in order to achieve low accuracy by GPS satellite map, on the epidemic area and the grid division, The ROS robot operating system can control the local surrounding environment of the car body, and the data platform and cloud server can schedule the food delivery car, so as to realize unmanned delivery from point to small areas.

2. ROS Robot Operating System

ROS is the English abbreviation of Robot Operating System[1]. ROS is a highly flexible software architecture for programming robot software. It includes a large number of Tools, library codes and conventions, aiming to simplify the difficulty and complexity of creating complex and robust robot behaviors across robot platforms. ROS is described as "ROS = Plumbing + Tools + Capabilities + Ecosystem". ROS is a collection of communication mechanisms, tools and software packages, high-level robotic skills, and robotic ecosystems. The distributed node communication mechanism of ROS system is shown in Figure 1 below[2].

ISSN: 2664-9640

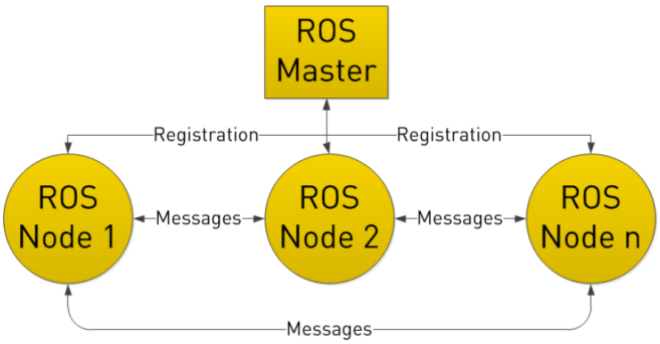

Figure 1: Distributed node communication mechanism of ROS system

To meet the requirements of precise navigation, path planning, traffic light detection[3], pedestrian avoidance and other functions of food delivery vehicles, the distributed node-like communication mechanism of ROS system can make the realization of food delivery vehicles' functions feasible.

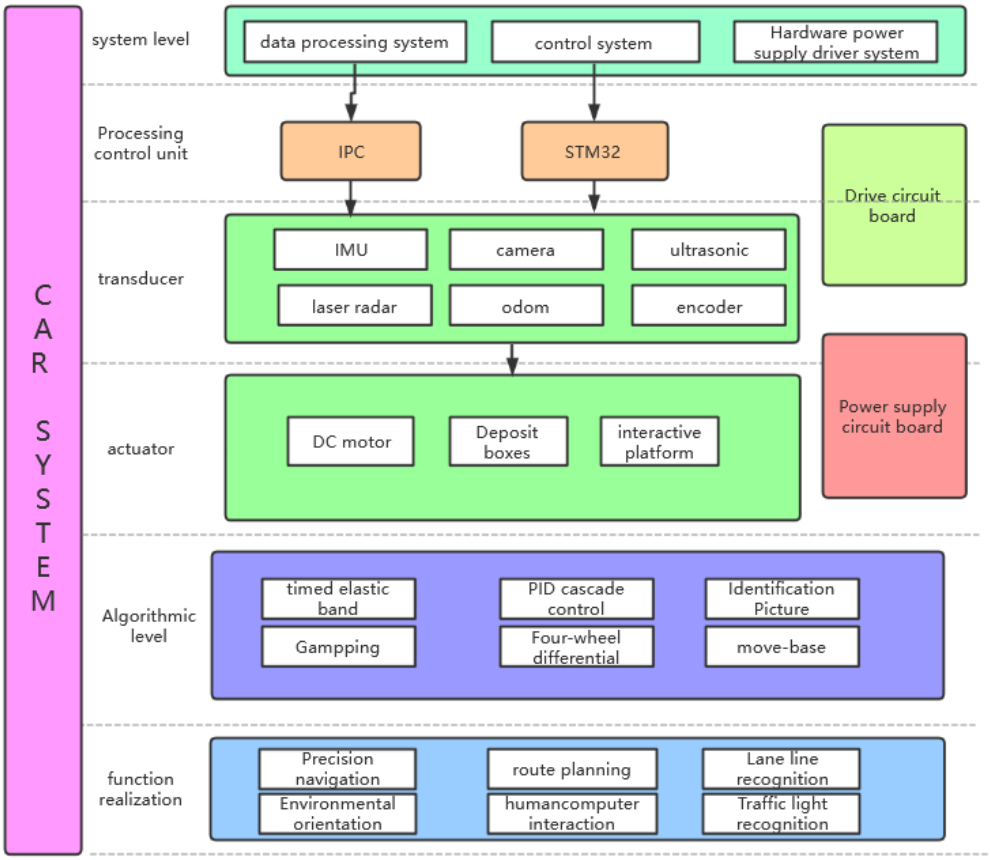

Figure 2: Design framework for food delivery truck system

3. Overall Framework Design of Food Delivery Car System Based on ROS

For unmanned carts function design, overall food conveyor system is divided into upper data processing system, the lower power drive system, control system and the hardware in the upper data processing system, used for carrying ROS (Kinetic) in industrial control of laser radar, cameras, IMU inertial unit sensor data fusion processing, such as lower level control system, STM32 microcontroller is used for data communication with the host computer, and the motor movement is controlled by control instructions. The hardware power supply and drive system of the car uses a 24v10A DC power supply to power the whole car, and two circuit

ISSN: 2664-9640

boards (drive board and power supply board) are designed to realize the power supply and drive part.

4. Lane Line to Identify[3]

Each pixel in the image is composed of RGB (red, green and blue) three color channels. To facilitate the description of RGB color model, the range from dark to light of each channel is constrained to be 0~255 in the computer.

When the R channel value of a pixel is 255, G and B channel value is 0, the actual color is the brightest red; When the RGB three channels of a pixel are 255, it represents the brightest white; When all three RGB channels of a pixel are 0, the darkest black will be displayed. In the RGB color model, there is no color brighter than the combination of [255,255,255].

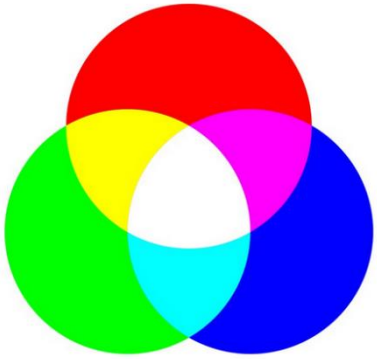

Figure 3: three primary colors of light

According to the above theoretical basis, RGB trichromatic image processing is carried out for each frame image collected by the camera.

Gray processing: Considering the complexity of processing the data of the three channels, we first gray processed the image. The gray processing process is to unify the RGB value of each pixel into the same value. After gray image will be changed from three channels into a single channel, single channel data processing will be much simpler.

Usually this value is calculated according to the value of RGB three channels. The sensitivity of human eyes to RGB colors is different, green is the most sensitive and has a higher weight, while blue is the least sensitive and has a lower weight. The specific calculation formula for gray-scale operation of pixels with coordinate (x,y) is as follows:

$$\mathrm{Gray}(x,y) = 0.299 \times red(x,y) + 0.587 \times green(x,\mathrm{y}) + 0.114 \times blue(x,y) \quad (1)$$

Edge extraction: In order to highlight the lane line, we do edge processing on the gray-scale image. "Edge" is the area with obvious altercation of light and dark in the image. The lane lines are usually white or yellow, and the ground is usually gray or black, so the edges of the lane lines are clearly shaded.

Straight line fitting, line detection for traditional lanes, majority is based on hoff straight line detection, but vulnerable to all kinds of noise interference, hough linear direct use sometimes the result is bad, design by using the tangent with the unit for differential fitting approximation pixels, the discrete pixels standard matching, curve under the unit circle tangent approximation, linear fitting again.

Figure 4 is the flow chart of the realization of the whole lane recognition function, and Figure 5 is the effect diagram produced by the experiment.

ISSN: 2664-9640

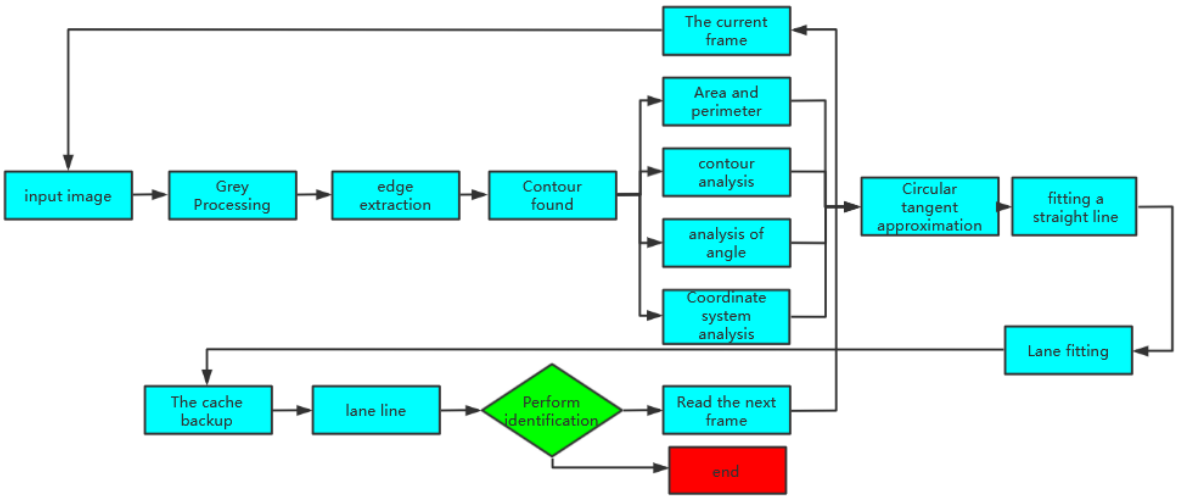

Figure 4: Lane Line Recognition Implementation

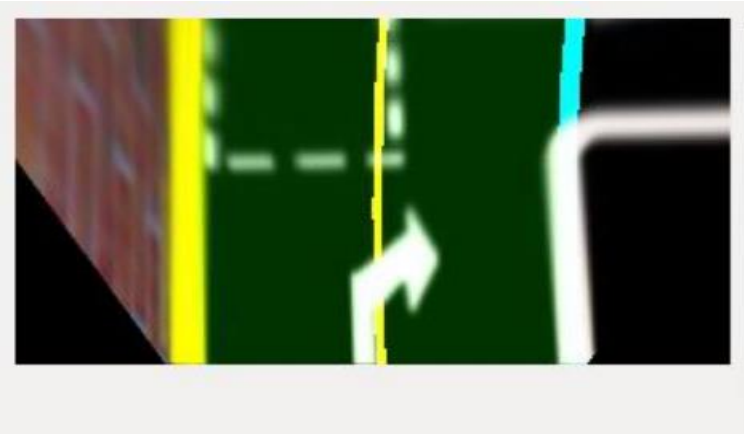

Figure 5: Experimental renderings

5. Precision Navigation

Under the precise navigation function of the food delivery car, the navigation function can be divided into three modules: perception, planning and control. Figure 6 is the structural logic introduction of the three modules. The food delivery car senses the surrounding complex environment mainly through sensors such as liDAR and ultrasound to realize the perception of pedestrians and vehicles. Through IMU, encoder and other sensors, vehicle positioning is carried out, and multi-sensor data is fused for positioning feedback to improve the accuracy. Timed elastic-band[4] algorithm is used in the positioning process. (The starting point and target point states are specified by the user/global planner. In the middle, N control points (robot posture) are inserted to control the shape of the rubber band. Of course, in order to display the kinematic information of the trajectory, we define the motion Time between points. Plan the direction and speed of the next step.

The realization of navigation module cannot be separated from the Move-base logic framework in ROS system. FIG. 7 Navigation framework logic diagram from ROS Wiki[5].

As can be seen from the general frame diagram, MOve-Base provides the configuration, operation and interaction interface of ROS navigation. It mainly includes two parts: Global Planner: the overall path planning is performed according to the given target location; Local Planner: Plan the escape route according to the nearby obstacles.

ISSN: 2664-9640

Global Planner: In the navigation, the global route of the robot to the target location is calculated through the global path planning. This functionality is implemented by the NavFN package.

Navfn uses Dijkstra's optimal path algorithm[6] to calculate the minimum cost path on CostMap as the global route of the robot. Meanwhile, Timed Elastic Band algorithm is used to update the route during the test. In this design, four-wheel differential site is used and TEB algorithm is selected. To improve the stability of the vehicle in the driving process, the following figure shows the main process of TEB trajectory planning.

Local Planner: The local real-time planner is implemented using the base_local_Planner package. The Trajectory Rollout and Dynamic Window Approaches algorithms are used to calculate the speed and Angle (dx, Dy, dtheta <e:3>) that the robot should travel in each cycle. The package base_local_planner uses map data to search for multiple paths to the target by algorithm, uses some evaluation criteria (whether it will hit obstacles, time required, etc.) to select the optimal path, and calculates the required real-time speed and Angle. The experimental effect is shown in Figure 9 below, the line planned by the black line diameter below

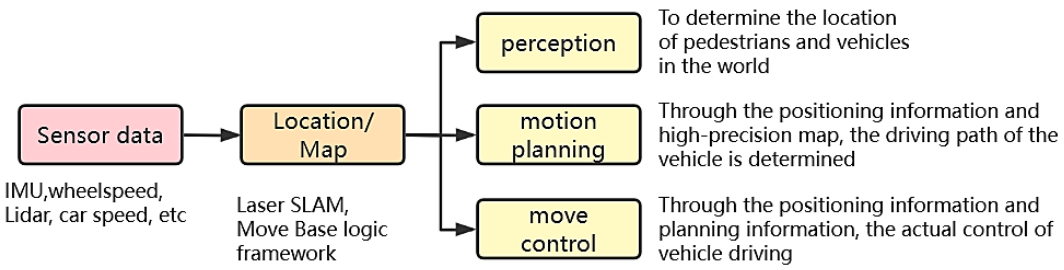

Figure 6: Three modules of navigation

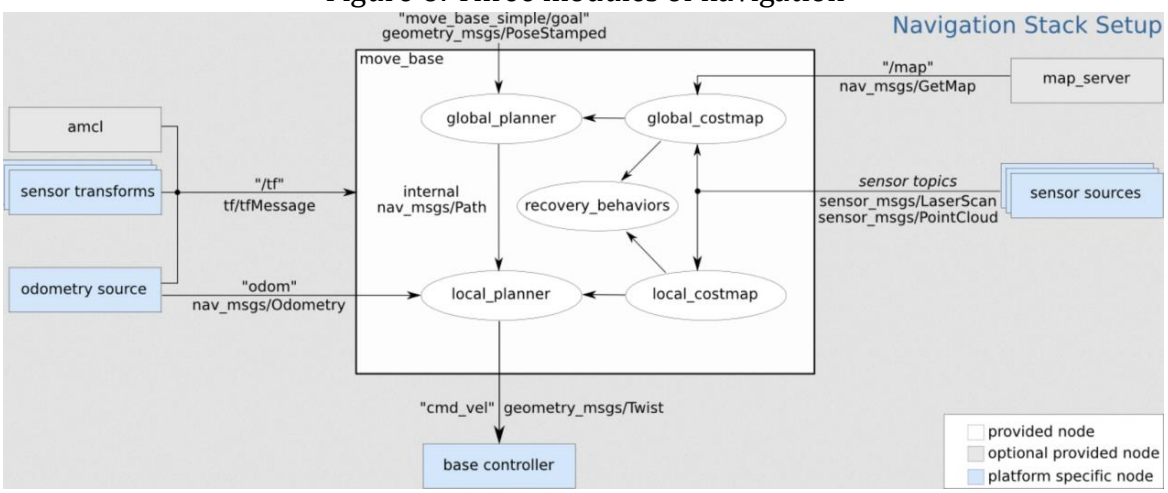

Figure 7: Move-base logical framework

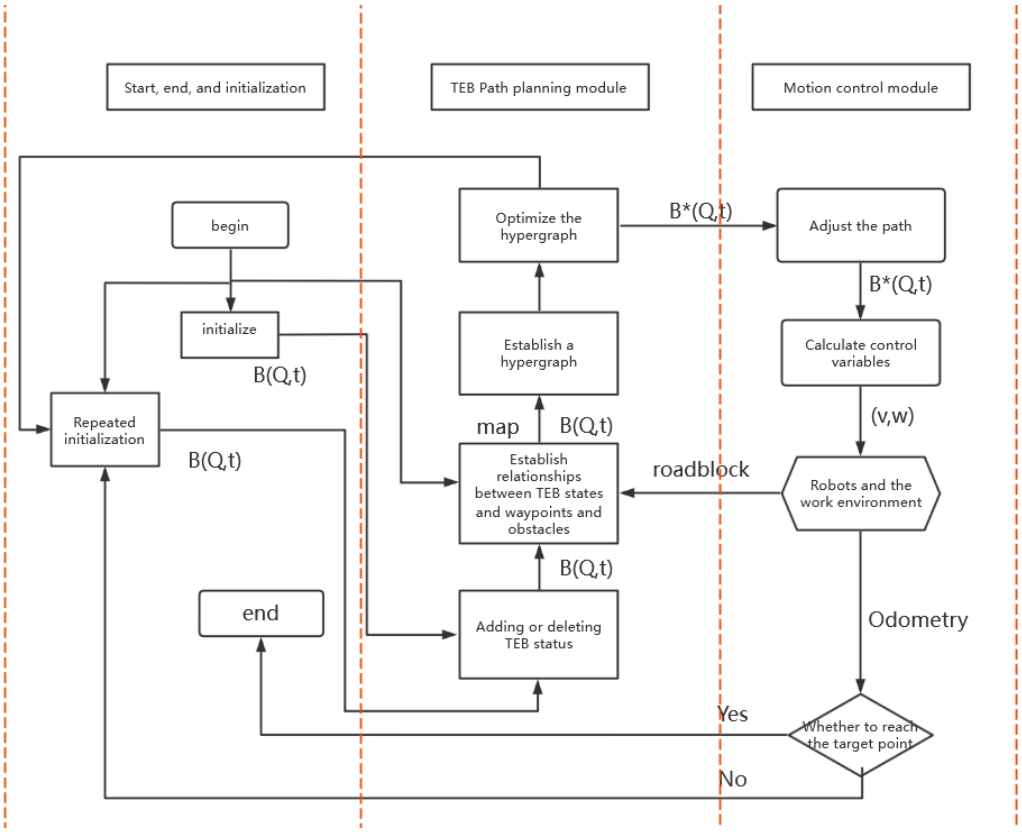

Figure 8: Trajectory planning process

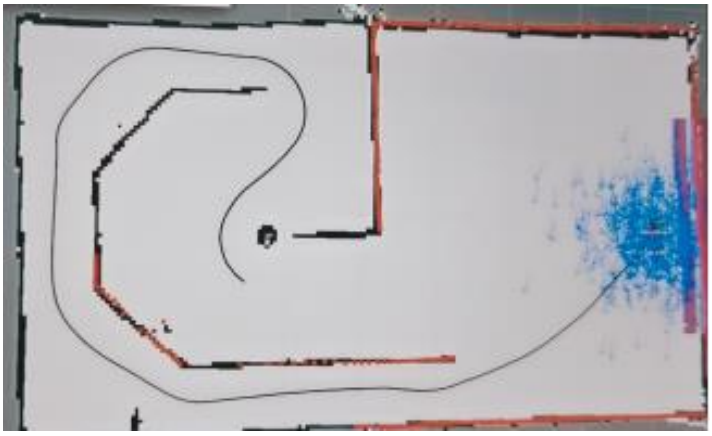

Figure 9: Path planning renderings

6. Concludes

This paper mainly introduces the intelligent unmanned food delivery vehicle in the direction of perceptual intelligence, mobile intelligence and precise navigation. Based on the ROS robot operating platform, it integrates and processes multi-sensor data such as IMU, camera and encoder to realize automatic food delivery in a closed environment. The robot design scheme is provided to solve the problems of goods and food delivery delay caused by personnel isolation due to epidemic and other factors.

References

[1] NIQUILLE S C. Regarding the pain of SpotMini: Or what a robot's struggle to learn reveals about the built environment［J］. Architectural Design, 2019, 89(1): 84-91.

[2] Li Yeqian, Chen Chunmiao. Design of automatic navigation system for mobile robots based on ROS and LiDAR. Modern Electronic Technology, 2022, 43(10):176-178+183
[3] N Y，GENG K，LIU S，et al． A new path tracking algorithm for four-wheel differential steering vehicle［C］//2019 Chinese Control and Decision Conference (CCDC) ， Nanchang，China， 2019: 1527 — 1532．
[4] Cheng Weiming. Research on path planning and tracking control technology in autonomous navigation of mobile robots [D]. Nanjing: Nanjing University of Science and Technology, 2007.
[5] Lun Yi. Development status and trend of autonomous driving industry [J]. Autonomous Driving, 2017, (6): 33-36
[6] Wu Jingyang. Development of a multi-autonomous mobile robot system based on lidar positioning and navigation [D]. Harbin: Harbin Institute of Technology, 2017.