Intelligent flexible traffic signal lamp control system based on PLC and HMI

Yunqi Yan [1, 2, a], Yun Xu [1, 2, b], Yinghua Liao [1, 2, c], Yingying Cui [3, d]

[1]School of Mechanical Engineering, Sichuan University of Science & Engineering, Zigong 643000, China.

[2]Sichuan Key Laboratory of process equipment and control engineering, Sichuan Zigong, 643000, China.

[3]No.7 middle school of Panzhihua City, Sichuan Panzhihua

[a]498513701@qq.com, [b]1214004131@qq.com, [c]liaoyinghua118@163.com,

[d]annie 729729@163.com

Abstract

An intelligent control system for traffic signal lamp studied in this paper. The control core of this is a PLC. The ground induction coil is a sensor that is used to detect the quantity of cars through entrance and exit to calculate traffic flow, and then the time of the green light changed with real-time traffic conditions. In order to modify the internal parameters of the control system according to the actual situation, and improve the flexiblity of the control system, the operation panel of the control system is made by HMI.

Keywords

ground Induction coil; intelligent traffic control; traffic flow.

1. Introduction

With the development of our society economy, people's living standards are improving, and more and more families have their own vehicles, which cause the problem of urban road congestion more and more obvious. At present, most of the traffic control signals in our country are controlled by fixed time operation mode. When a direction of flow is less than in the other direction of traffic, the car that is stuck in the small traffic direction will soon be cleared out. In the opposite case, the traffic jams and inefficient traffic will constantly come out in the cycle. Furthermore, the current control time of the large part of the traffic control signal system is custom-made and cannot be modified. If the control time needs to be changed, it relys on the technician's maintenance of manufacturer, which costs a certain amount of money. Therefore, an intelligent and flexible intersections control system is imperative.

2. The Whole Scheme Design of Intelligent and Flexible Traffic Light Control System

2.1 The Investigate and Survey of Crossroads Traffic Situation

A city crossroad, whose road in east-west direction is the main road connected to the center of city and the city's central bus station is also concentrated in it. In general, the time from 7 o 'clock to 21 o 'clock in this main road belongs to peak time, especially the commuting time of daytime, the traffic volume is bigger. Furthermore, the south-north direction is the secondary road connected to some communities

and a university, which traffic volume is slightly smaller compared to the east-west direction road, sometimes there will be particularly small traffic, which cause the green time is not over when stranded vehicles have all driven out of the intersection.

According to the number of stranded vehicles and differential vehicles in all directions, using the way of combination of PLC controller and sensor to extend green time appropriately or reduce the green light time ,which can realize allocating traffic time rationally and reduce waiting time.

2.2 Control Scheme

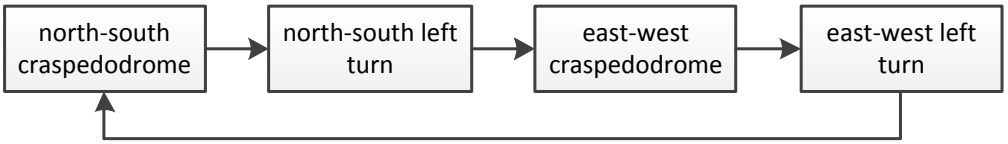

Fig.1 the traffic plan

Traffic plan follows the principle of first straight and left turn after. Each cycle begins with the straight in north-south direction as shown in figure 1. In addition, the control system should also have the following functions:

1.The control scheme is divided into manual mode and automatic mode.

2.In the manual mode, we can manually connect to any light group of any direction when special situations or emergencies emerged in the intersection .

3.Automatic mode is divided into daytime mode and night mode.

4.In the daytime mode, it can automatically change the green time according to the traffic volume, the specific plans are as follow:

(1) If differential values of straight forward vehicles between current direction and the other direction exceed δ, extending the current straight time T_1, if the negative differential values exceed -δ, reducing the current straight time T_2, if there is no straight forward vehicles currently, then switching to left turn in current direction.

(2) If differential values of left turn vehicles between current direction and the other direction exceed δ, extending the current left turn time T_1, if the negative differential values exceed -δ, reducing the current left turn time T_2, if there is no left turn vehicles currently, then switching to straight forward in other direction and repeating cycles.

5.In the night mode, the traffic reduces, all the external sensors are turned off, the yellow lights in all the directions flash to remind vehicles to slow down and save energy.

2.3 System Composition

The system is mainly composed of sense coil (sensor), vehicle detector (signal conversion device), PLC (controller), HMI (man-machine interface) and traffic signal lights. The main structure is shown in figure 2.

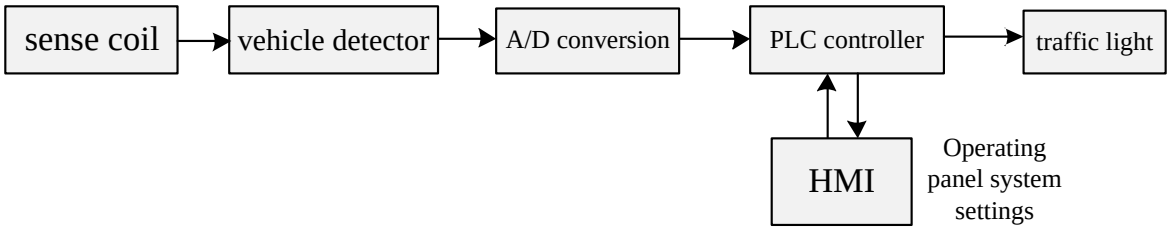

Fig.2 system structure diagram

2.4 Sensor System

Two ground sense coils are laid in a single lane of L long distance, which are used to count vehicle values in inlet and outlet in each intersection. Through calculation, we can get real-time stranded car numbers, as shown in figure 3. The distance between the two sets of coils is based on the average queuing distance of vehicles at peak times.

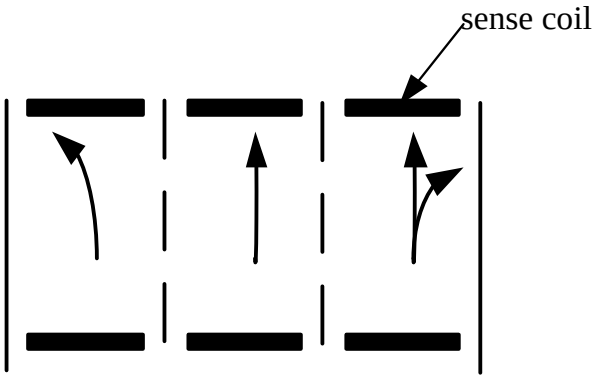

Fig.3 laying diagram of the sense coil

The Inductance generated by ground sense coil is analog value, through the vehicle detector, the analog value can be converted into digital data and transmitted to the PLC, finally achieving the count.

3. PLC Program

To make it easy to modify the system control parameters, we set up DB blocks (data blocks), and write the control parameters into the DB block. Therefore, it can be easily read and rewrite the data by the PLC program instructions and the HMI devices The overall design of the program is shown in figure 4.

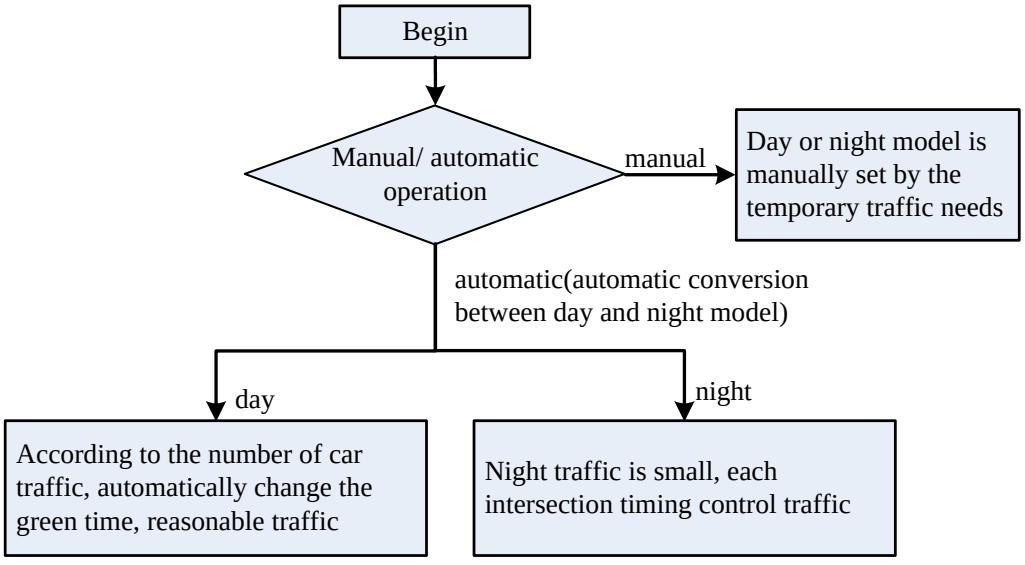

Fig.4 program flow

The OB block is used to write the invocation style and structure of the overall module in system. Each function that needs to be implemented is written to the different FC, such as manual control, automatic control, indicator light output, time calculation, vehicle measurement and so on. Then all kinds of data produced by logic operations of control system and sensors (such as: vehicle number, the number of green time, the green light time and so on) are written separately into different DB (global data) block. This kind of application system can make each piece, both in the early writing or in the maintenance of the late, to read the meaning of the program quickly and easily, and save a lot of time. function block is shown in figure 5.

OB1	
FC10	manual operation
FC11	counter
FC12	Automatic and manual switching
FC13	Automatic north-south operation
FC14	Automatic east – west operation
FC15	Light output
DB10	Manual mode
DB11	Light
DB12	Automatic mode
DB13	Touch screen Settings
DB14	Automatic step

Fig.5 function block

Since the data in the DB block can be directly linked to the HMI device, we can use it to set up the relevant control messages in the HMI device to change the parameters of the traffic control system. For this point, we can independently complete the change of traffic control scheme without the aid of equipment manufacturers.

For different urban roads, as well as different intersections, the control mode is inconsistent, the traffic lights produced by many manufacturers are customized for each intersection, engineers arrived at the scene to modify the program according to the traffic condition (the main change in passing time). Therefore, this method can make the system be applicable to different urban road intersections without engineers and complete setting system control parameters. As shown in figure 6.

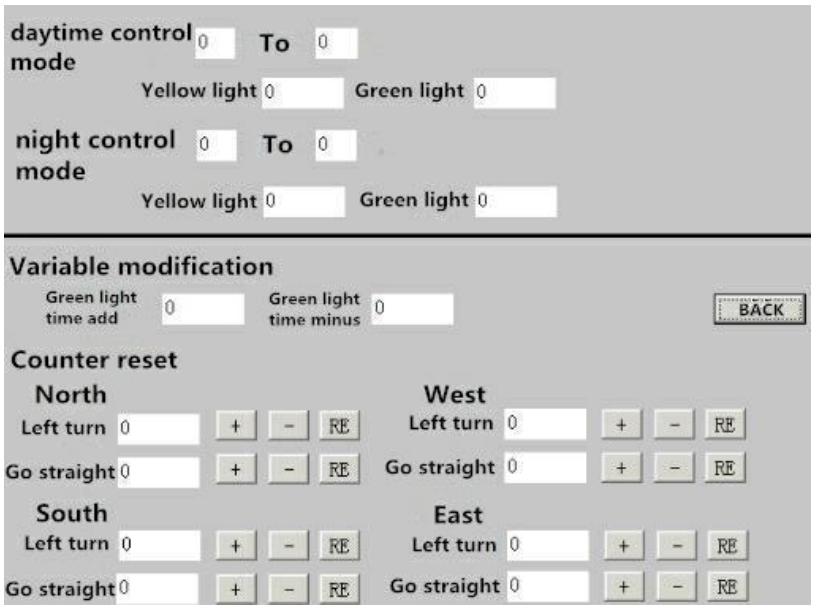

Fig. 6 control system settings

In HMI devices, we can not only process "system settings", but also set up the monitor screen to monitor the running state of system. The manual control screen will replace the traditional button, by which can increase and decrease of soft components and realize more functions based on the functional requirements in the condition of unchanging the hardware structure. As shown in figure 7 and figure 8.

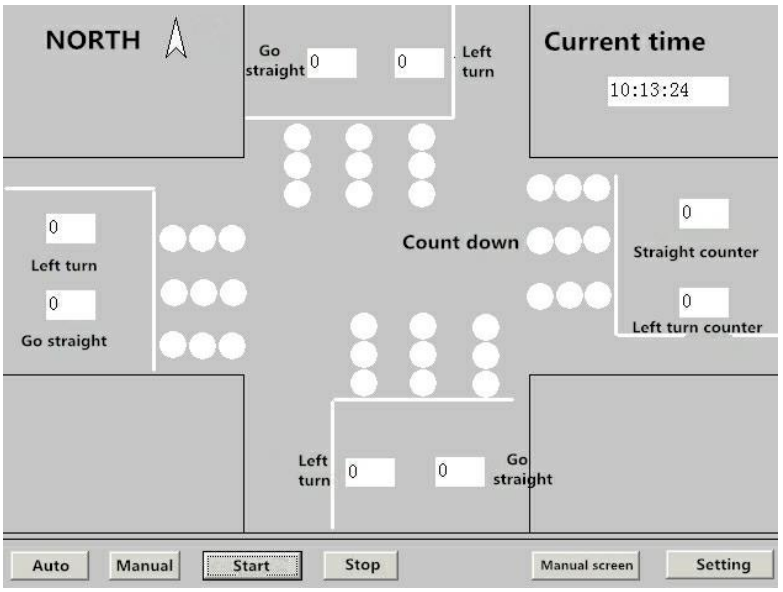

Fig. 7 control and monitoring screen

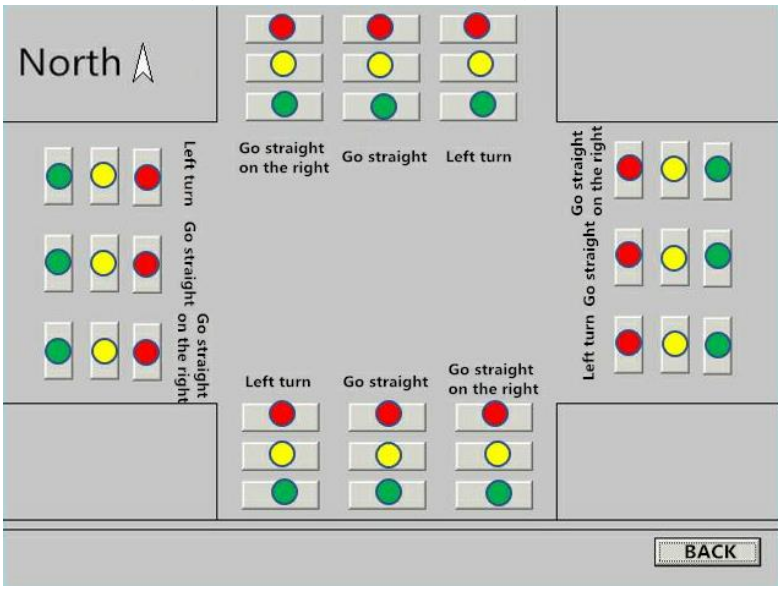

Fig.8 manual control screen

4. Conclusion

PLC has the advantages of high reliability, strong anti-interference ability, convenient control and so on. Using the method that combining PLC and sense coil as the traffic light control system, which can reduce the waiting time in the intersections and optimize the traffic condition. At the same time, making HMI equipment as the operating panel of the control system, whose interface is simple and intuitive, through the HMI device to modify the data of the control system and apply the set of traffic control system to different intersections in different cities, which increase flexible control and propose a new idea to alleviate traffic jam.

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