

Application of Intelligent Traffic Control Based on PLC

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Abstract-As we know, the transport system is a complex system of ambiguity, randomness and uncertainty . It is very difficult to establish the mathematical model and sometimes it is impossible to use the existing mathematical methods to describe it. At the current inside the country the traffic lights at crossroads is generally controlled by the timing switch. At present domestic urban transport is commonly used in the timer traffic lights to control the passage of vehicles, with the occurrence of uncertainties and the ground conditions often changing. According to the difference of the vehicles stagnation flow and the traffic lights time lengths of holdup at any each intersection, to use the Siemens S7-200 programmable control system automatically adjusts traffic lights and vehicles circulation. The application of the system will greatly alleviate the traffic congestion, improve the efficiency of road, and make a contribution to energy conservation and emission reduction. In the future we will be living in the era with the smooth traffic flow, the good environment and social sustainable development.

Keywords-stagnation flow; PLC; Intelligent control

I. INTRODUCTION

Nowadays, with the social progress and economic development, the transport is playing a pivotal role in cities. However, the main "bottleneck" problem is that the vehicle congestion phenomenon often occurs in urban intersection to cause traffic jams.^[1] And the smooth passage of traffic is suffering from huge pressure, causing people to pay more attention to traffic safety. At present, a variety of traffic control systems has been established in the majority of our city, the timer control mainly occupies a large proportion in the control of traffic lights, whose work efficiency mode is relatively low. Not only in this way is the phenomenon likely to cause traffic jams, but also cause a waste of human and material resources. Therefore, we need to seek an intelligent traffic control system based on the change in traffic flow, and it can automatically adjust the length of time of the traffic lights to minimize crossroads vehicles stagnation phenomenon. By researching on the urban traffic signal control system, to design a versatile intelligent traffic control communications program, which can achieve traffic intersection intelligent management. In order to effectively improve the junction capacity, relying on the Intelligent Auto Adjustment system, it's able to direct traffic control system in an orderly, alleviate traffic congestion, reduce vehicle stranded, achieve optimal control, and improve good control effect with PLC control.

II. THE INTELLIGENT CONTROL SYSTEM DESIGN

A. Control system components

The system mainly consists of the vehicle sensor detectors, PLC, traffic red, yellow, green lights and power components, shown in Figure 1. The control system uses the Siemens PLC with easy programming, simple system, short development cycles, high reliability, save costs and convenient installation and maintenance, etc. Especially it is suitable for heavy traffic and overpass crossroads.

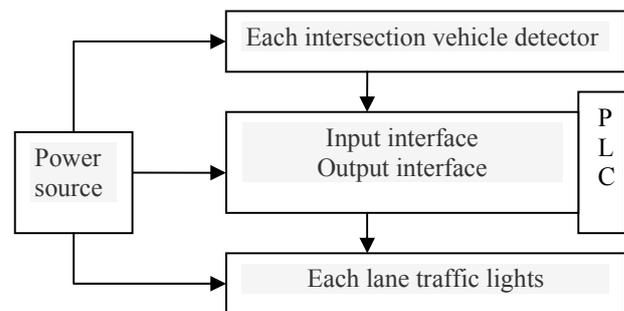


Figure1. Intelligent control system

From figure 1 we can know vehicle detector for detecting a vehicle through the signal whose information input to the PLC high-speed counter. The counter's frequency meets to detect vehicle requirements. With only six high-speed counters in the PLC, they can be used to work at the same time, whose number is limited. thus, its result that the vehicle exit speed is generally slow-moving. As we know, PLC has advantages of high reliability, strong anti-jamming capability, simple programming, strong adaptability, and low cost. PLC, as parts of the intelligent traffic light system, can operate properly in harsh electromagnetic interference environment. Thus, the PLC internal counters can count the vehicle obtained by the vehicle detection signal. It is detecting the two sensors spacing that which is the normal driving maximum allowable parking car long on the same lane.

B. Detection circuit

When detecting vehicles pass through or the presence of vehicles, how to handle it, as follows: the detectors, can detect the amplitude change of the inductance, are connected to the starting end of the insulating ring induction coil, receiving an electrical signal and transforming it into

the standard of the pulse voltage that outputs the single lane vehicle testing, directly entering into the PLC.^[2] These inductive sensors model need to select with the high-frequency current frequency 60KHz, size 2X3m, inductance of about 100μH and can detect the inductance of the change rate more than 0.3%. What's more, the detecting circuit system components: the signal source circuit, detector circuit, comparator discriminating circuit is composed of three parts. The schematic diagram shown in Figure 2:

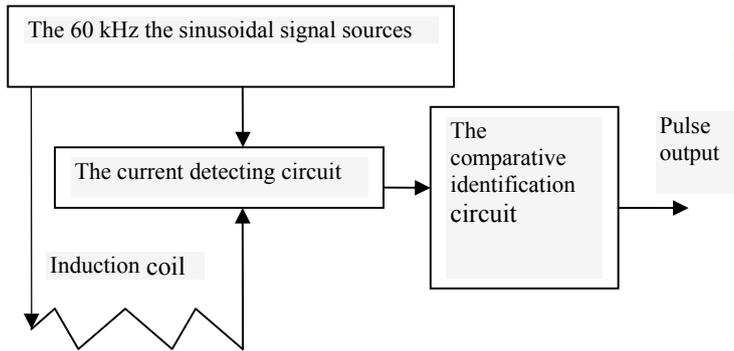


Figure 2 Detection circuit schematics

C. System data acquisition

There are vehicles traveling the four directions of east, west, south and north, of each the lane direction turn right, go straight and turn left to travel three lane traffics. As shown in Figure 3, the crossroad traffic detection layout. At the entrance to form a detection zone, setting signal detection sensors in the vehicle traveling, the one set at a stopping lines, used to detect the lane number of vehicles leave; and the one set at the distal end, used to detect the lane number of vehicle arrives.^[3] In order to get the intersection traffic flow information, we adopt detection sensors for real-time monitoring to deal with meaningful data for intelligent control. Further explanation, to improve the efficiency of the traffic control system, it is necessary to design an intelligent traffic control system, and it can vary from the road conditions and seasonal changes, or automatically adjust the length of time of the traffic lights to minimize the crossroads the vehicle stagnation phenomenon, improve effective mitigation of traffic congestion and achieve the optimal control of the traffic control system. To this end, the following scheme can be used to conduct the traffic control: First of all, using the inductive sensor to detect the flow rate of the vehicle to obtain the vehicle pulse, and then this pulse is inputted to the PLC; taking into account the frequency of the pulses of the vehicle, the high-speed counters within the PLC count the rising edge of the vehicles pulses, at a certain intelligent control principle automatically adjust the traffic lights' length of time.

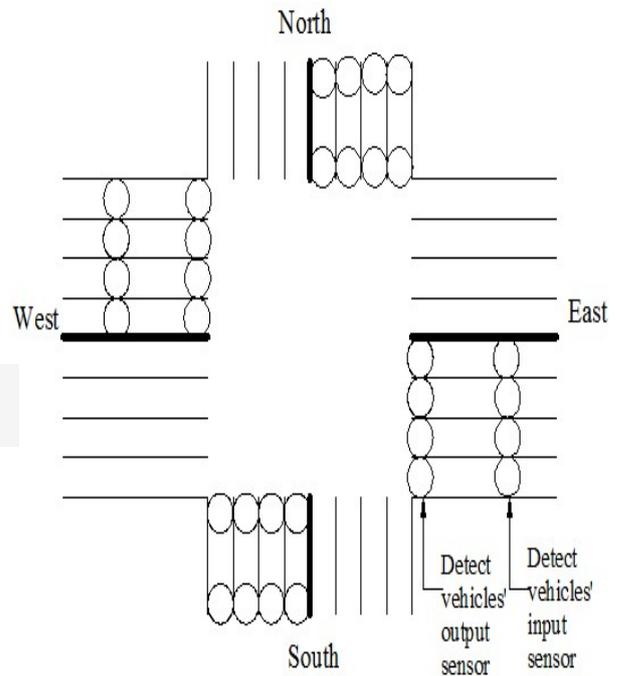


Figure 3 sensor coil laying diagram

D. The system intelligent control principle and implementation

The core of this traffic control system is PLC intelligent control, according to the count result of the traffic flow; the system automatically output the pulses to adjust the length of time to Traffic light. According to the traffic vehicles change at the crossroads, the vehicles of north-south direction stop or run at the same time, so do the east-west direction. Therefore, the system compares to the maximum value of the vehicle in the South-North and the East-West directions to clearly know the road crossroads traffic lights achieving real-time control. Meanwhile, the Siemens S7-200 series is a small model PLC, its strengths is that the control ability rather than the complex logic operations, in order to simplify the logic operation, improving the output speed of PLC control, the system uses control principle that controlling by "the traffic flow sub-file" way : the vehicle flow in the east-west or in the north-south direction set by the sub-file the traffic flow scale, Correspondingly the system set the time length of the traffic green lights in the east-west or north-south direction according to certain rules.^[4] This can be achieved by traffic volume scale to formulate the green light, to achieve maximum car clearance, reduce the crossroads vehicles stagnation, alleviate traffic congestion and acquire optimal control, thereby improving the efficiency of the traffic control system. Specific implementation is shown the following assumptions: considering the upper, middle and lower into third gear, we can control the green lights time long of the

east-west direction, whose traffic flow is small scale, while the north-south direction of traffic flow is the same small scale in the length of time. It can draw a conclusion to select a middle length of time, otherwise to select small scale in the length of time; if the size of the east-west direction of traffic flow is the middle scale, regardless of the size of the north-south direction of traffic flow, carrying out the middle of time; if the size of the east-west direction of traffic flow is the big scale, while the north and south direction of traffic flow scale is the same as the big, taking in the middle length of time (in order to speed up the frequency of traffic flow and improve the efficiency of the system), otherwise selecting the length of time pass. The east-west direction and the north-south direction the long of traffic green lights logical operators are shown in Table 1-4. (Realize intermediate relay within PLC).

Table 1 shows the east-west direction lane traffic flow comparison (M1, M2 and M3 denote the east lane of traffic volume, small, middle and large scale; while M4, M5 and M6 denote the west lane of traffic volume is small, middle and large)

East and west lane traffic flow	East lane traffic flow			
	West lane traffic flow	small(M1)	middle(M2)	big(M3)
small(M4)	small(M501)	middle(M502)	big(M503)	
middle(M5)	middle(M502)	middle(M502)	big(M503)	
big(M6)	big(M503)	big(M503)	big(M503)	

The east and west lane traffic flow logic operation results can be obtained from Table 1: small (M501): $M1 * M4$; middle (M502): $M2 * M4 + M5 * (M1 + M2)$; large (M503): $M3 + M6$.

Table 2 describes the south-north direction lane traffic flow comparison (M7, M8 and M9 respectively the north lane of traffic flow is small, middle and large scale; while M10, M11 and M12 respectively denote the south lane of traffic flow is small, middle and large).

south and north lane traffic flow	south lane traffic flow			
	north lane traffic flow	small(M7)	middle(M8)	big(M9)
small(M10)	small(M504)	middle(M505)	big(M506)	
middle(M11)	middle(M505)	middle(M505)	big(M506)	
big(M12)	big(M506)	big(M506)	big(M506)	

The north and south lane traffic scale logic operation results can be gained from table 2: small (M504): $M7 * M10$; middle (M505): $M7 * M11 + M8 * (M10 + M11)$; large (M506): $M9 + M12$;

Table 3 is shown the east-west green time length control (M501, M502 and M503 respectively reflect the east-west traffic flow small, middle and large scale; while M504, M505 and M506 respectively reflect the north-south traffic flow small, middle and large).

east-west green time length	north-south lane traffic flow			
	east-west lane traffic flow	small(M504)	middle(M505)	big(M506)
small(M501)	middle	small	small	
middle(M502)	middle	middle	middle	
big(M503)	big	big	middle	

The east-west direction of the length of the green time logic operation results from Table 3:

small: $M501*(M505+M506)$;
 middle: $M501*M504+M503*M506+M502$;
 big: $M503*(M504+M505)$;

Table 4 is shown green time length control (M501, M502 and M503 respectively reflect the east-west traffic flow, small, middle and large scale traffic flow; while M504, M505 and M506 reflect the small size of the north-south traffic flow, small, middle and large).

south-north lane traffic flow	east-west lane traffic flow			
		small(M501)	middle(M502)	big(M503)
small(M504)	middle	small	small	
middle(M505)	middle	middle	middle	
big(M506)	big	big	middle	

Table 4 was a north-south green light long logical result of the operation: small: $M504*(M502+M503)$; middle: $M501*M504+M503*M506+M505$;
 Large: $M506*(M501+M502)$;

The vehicles count the traffic volume comparison as well as the green time length control completed all by the PLC. Under the control of a traffic lights cycle, until the east-west or the south-north of the traffic flow green lights, PLC will count at high speed and collect internal counter data. The data comes from the the high-speed counters count value minus the internal counter count value to process the road traffic vehicles stagnation (so do other roads). And then adjust the road traffic volume scale to determine the east-west and north-south of the traffic flow scale. Finally, according to the above intelligent control principle, adjusting the traffic green lights time. After the traffic green lights time outputting, the internal counter is cleared immediately and continues to count, at the same time the high-speed counter continues to count on the basis of the original stagnation flow, preparing for the next traffic light cycle. Of course, the above traffic volume size and the traffic green time can easily change with the road and the season changes.^[5-7]

III. PLC CONTROL PROGRAM DESIGN

PLC programming is an important part of the system, the method combining Sequential Function Chart with ladder diagram designs PLC control program. The Crossroads traffic lights intelligent control block diagram can be seen from Figure 3. The PLC program debugging verifies the above PLC intelligent control principle.

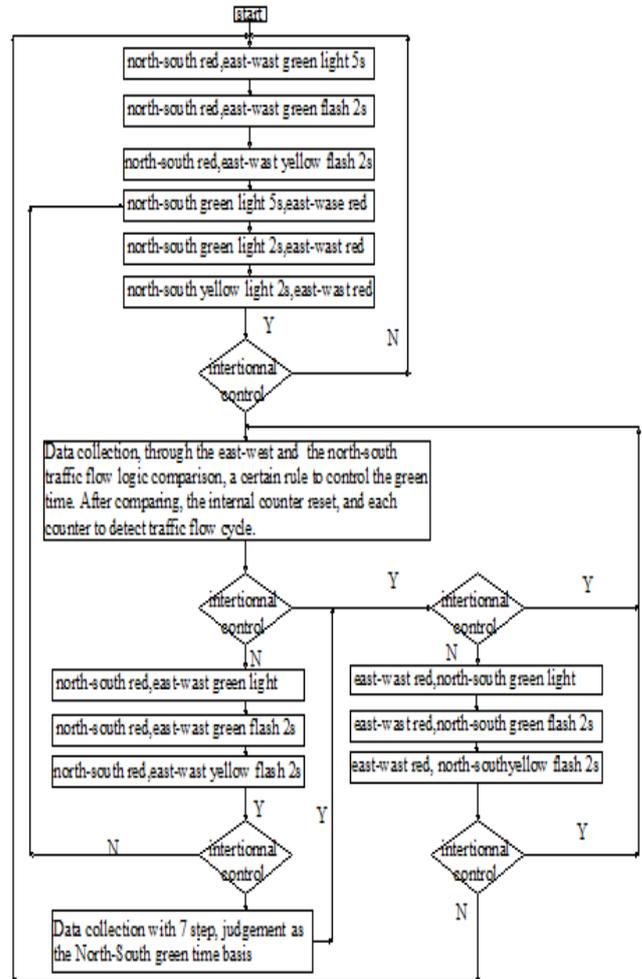


Figure 3 traffic lights intelligent control program flow chart

IV. CONCLUSIONS

With the increasing development of transportation, the increase in vehicles traffic is suffering from unprecedented challenges. [8]The system can improve the efficiency of traffic control, and also is a kind of intelligent traffic control system, so, it can automatically adjust the time length of the traffic lights based on the road and seasonal changes, to reduce the crossroads vehicles stagnation, relieve traffic congestion and improve traffic control system optimal control. In a word, the future will trend towards the development of intelligent control direction. Countries all over the world are also actively taken measures to enhance a high-speed and improve energy-efficient the prevailing

environment, making a contribution to energy conservation and emission reduction.

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