The Optimal Arterial Signal Control System in

Ping ding shan City, China

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Abstract: Urban arterial road is the main undertaker for the urban transportation. The transportation capacity can be enhanced by combining and controlling many intersections in one main road. Arterial traffic signal coordination control is an important part of intelligent transportation system (ITS), and it plays a significant role in relieving traffic congestion and improving traffic efficiency of intersections and highway network. Some crossroads and section of a street are special handling in order to make all the street fit the line control system better. The system setting make a good effect, and is proved by comparing and analyzes the delay between earlier and final system setting. In this paper, a phase sequence optimization model was presented based on the idea of maximization of two way green wave bandwidth. VISSIM was used for testifying the effectiveness of the optimization model. This can provide smart transportation.

Key words: Intersection, Signal control, Phase sequence, Simulation.

1. INTRODUCTION

The transportation capacity can be improved by combining and controlling many intersections in one main road. This can decrease congestion, reduce the environmental pollution and add the economy of city. This can provide smart transportation. Now, researches have been mature only for the isolated intersection, but the research of the artery control and the regional control is not deep enough. Trunk road intersection signal control and timing design are the key to solve the problem of arterial road traffic. And fewer make the linear control for the peak traffic flow, the peak traffic flow is also a key factor to influence all network fluency. For urban roads, the intersection traffic operation state is closely related to the traffic operation state of city road, the Kuang gong road is the artery, which is a big problem in Ping ding shan. The road canalization is unreasonable. Sometimes the green light time is too short in the peak traffic flow, which leads to parking twice. With in the Ping ding shan car ownership increasing, the number of vehicles increased
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on the road. This greatly affects the flow and speed of traffic, so the road sets up signal coordinated control of the main intersection traffic immediately.

This paper takes the optimal arterial signal control system of Kuang gong road in Ping ding shan, as the research object in Ping ding shan. City trunk road takes the main traffic volume of the city. Combining a number of crossroads can greatly improve the traffic capacity, economize the vehicle time of stopping and waiting, improve the overall efficiency of road facilities, and optimize the existing traffic signal control. The Kuang gong road is east-west direction of a two-way four lane highway, and one of the main roads in Ping ding shan city. This design carries on the traffic flow statistics data through the investigation of each cross traffic. On the basis of collecting the survey data, a single intersection signal timing is determined for the whole intersection timing plan, thus designing the line control for the road is to reduce the delay and improve traffic efficiency.

2. LITERATURE REVIEW

Bell introduced genetic algorithm in the aspects of traffic control parameters, through traffic signal control parameter, in order to get the signal timing plans[1]. American J.D.C.Litter and W.D.Brooks using the phase difference of maximum bandwidth optimization method developed MAXBAND[2]. Park developed MULTIBAND[3] (Multi-Bandwidth Traffic Signal Setting Optimization Program). Park proposed a random signal which is used to optimize the fixed cycle method[4]. Bell and J Larsen proposed a kind method to control and optimize phase difference based on the periodic random signal optimization method[5]. Wan xu jun introduced the heuristic algorithm optimizing traffic control parameters to obtain the optimized traffic signal timing scheme[6].

These papers put forward the fundamental arithmetic, for example phase difference maximum bandwidth optimization method, optimizing the fixed cycle method and so on, but these researches have a lot of limitations. For example these researches have been mature only for the isolated intersection, and the research of the artery control and the regional control is not deep enough. Because every intersection is a node of the urban traffic network, and its working state is bound to be influenced by the state of its adjacent nodes. In addition, especially urban trunk line in the peak traffic flow, due to the traffic flow encountered a red light and stopped in most intersection, congestion will spread to a larger area, the negative effects of urban traffic congestion is extremely serious. Therefore, this paper aims at optimizing arterial signal control of the peak traffic flow, with combining the above method.

3. DATA

3.1 Selecting the intersection

This paper selects the following three intersections based on the traffic arrival characteristics, i.e. the adjacent intersection spacing, signal phase setting conditions and traffic fluctuation. The Kuang gong road and Kai yuan road intersection is denoted as intersection A, the Kuang gong road and Lao dong road intersection as intersection B, the Kuang gong road and Xin hua road intersection as intersection C.
Because of the continuous intersection distance is too large, those do not meet the requirements, there is a multiple cross intersection, T intersection, which do not meet the requirements, only the three continuous intersections meet the requirements.

3.2 Traffic volume and signal timing census

Take the Kuang gong road and Kai yuan road intersection as an example. The intersection is four phase signal control intersection, the east-west direction includes a left turn lane, two through lanes and a right turn lane. North direction has a left turn lane, a through lane and a right lane. South direction consists of a left turn lane and a straight right lane, which right turning signal timing is evergreen. In the basic situation of the traffic the main road is east-west direction. The vehicle is mainly small cars and buses. West direction bus is more in this intersection. The following chart is traffic canalization.

![Figure 1 Kuang gong road present intersection canalization](image)

This paper selects early peak hours normal working day, in order to obtain the real peak data, survey time is 7:15~8:45. The east-west direction plans three people each, who the first one is responsible for traffic volume of left turn lane, the second one is responsible for traffic volume of right turn lane, the third one is responsible for traffic volume of two through lanes. The north direction arranges three people who the first one is responsible for volume of left turn lane, the second one is responsible for volume of right lane, the third one is responsible for volume of straight lane. The south direction has two people, who one is responsible for volume of left turn lane, the other one is responsible for volume of the straight right lane.

This census adopts artificial counting method for traffic. Every 15 minutes is a group of data. Because this group is the accurate statistics. In an hour, there are six group of data. Adding these data can obtain every direction the total traffic volume. The following table is this intersection traffic volume every direction every lane.
Table 2 Kuangguang road-Kaiyuan road intersection each flow table of peak hour

<table>
<thead>
<tr>
<th>Flow direction</th>
<th>Through lane</th>
<th>Turn lane</th>
<th>Right lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-direction</td>
<td>782</td>
<td>231</td>
<td>246</td>
</tr>
<tr>
<td>West-direction</td>
<td>886</td>
<td>216</td>
<td>284</td>
</tr>
<tr>
<td>South-direction</td>
<td>345</td>
<td>211</td>
<td>112</td>
</tr>
<tr>
<td>North-direction</td>
<td>363</td>
<td>200</td>
<td>213</td>
</tr>
</tbody>
</table>

Worker conducts signal timing census after finishing above work. The following chart is this intersection signal timing.

Figure 2 Kuanggong road and Kaiyuan road present signal timing

This intersection signal cycle time is 141s. The intersection is the four phase signal control.

4. METHOD AND DATA PROCESSING

4.1 Design of single intersection signal timing

4.1.1 Saturated flow calculation

Saturation flow can use the measured average saturation flow rate multiplied by the each influence factors correction coefficient, that is approaches estimating saturation flow rate.

\[ S_i = S_{bi} \times f(F_i) \]  

(Eq.1)

Which:  
- \( S_i \) —— Approaches estimating saturation flow rate, pcu/h.
- \( S_{bi} \) —— Section i entrance lane base saturation flow, pcu/h, \( i \) using T, L or R respectively express corresponding through, left turn or right turn, the above is same.
- \( f(F_i) \) —— the each influence factors correction coefficient.

1. Base saturation flow

Various types of imported lane has its own special the base saturation flow, the value is in table 3.
Table 3 the base saturation flow of various types of import lanes

<table>
<thead>
<tr>
<th>lane</th>
<th>$S_{bi}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through lane</td>
<td>1400-2000 average1650</td>
</tr>
<tr>
<td>Left turn lane</td>
<td>1300-1800 average1550</td>
</tr>
<tr>
<td>Right turn lane</td>
<td>1550</td>
</tr>
</tbody>
</table>

Various Lane general correction factor

1) Lane width correction

$$f_w = \begin{cases} 
1 & 3.0 \leq W \leq 3.5 \\
0.4(W - 0.5) & 2.7 \leq W < 3.0 \\
0.05(W + 16.5) & W > 3.5 
\end{cases} \quad \text{(Ep.2)}$$

Which: $w$—Lane width, m.

2) slope and big car correction

$$f_g = 1 - (G + HV) \quad \text{(Ep.3)}$$

Which: $G$ — Road Longitudinal Slope, downhill slope using0; $HV$ — big car rate, where, $HV$ not more than0.50.

3) Straight lane saturation flow

$$f_b = \left\{ \begin{array}{l}
1 - \frac{1 + \sqrt{b_L}}{g_e} \\
1
\end{array} \right. \quad \text{(Ep.4)}$$

Which: $f_b$—bicycle effect correction coefficient; $b_L$—the number of bicycle traffic lights turn left, pcu/h.

Straight driving saturation:

$$S_f = S_{bi} \times f_w \times f_g \times f_b \quad \text{(Ep.5)}$$

4) Exclusive left turn lane saturation

A special phase:

$$S_L = S_{bi} \times f_w \times f_g \quad \text{(Ep.6)}$$

Which: $S_L$—when there are exclusive left turn phase, the left turn lane saturation flow, pcu/h.

$S_{bi}$—when there are exclusive left turn phase, Base saturation flow, pcu/h.

5) Exclusive right turn lane saturation flow

No special phase:

$$S_R^\prime = S_{bb} \times f_w \times f_g \times f_r \times f_{br} \quad \text{(Ep.7)}$$

Which: $S_R^\prime$—When there is no special phase, the right turn lane saturation flow, pcu/h.
Pbf —Pedestrian or bicycle effect correction coefficient, by the following formula:

\[
f_{pbf} = \min \left[ f_p, f_b' \right]
\]  

(Ep.8)  

Which:  

- \( f_p \) —According to the table;  
- \( f_b' \) —Bicycle effect correction coefficient, by the following formula:

\[
f_b' = 1 - \frac{t_r}{g_j}
\]  

(Ep.9)  

Which:  

- \( g_j \) —The phase displays green lights time, s;  
- \( t_r \) —At the beginning of green time straight bicycle occupied time out of the stop line, s ,by the following formula:

\[
t_r = \frac{3600(1 - \ell) b_r}{S_{ts} W_b}
\]  

(Ep.10)  

Which:  

- \( b_r \) —Straight bicycles per cycle average traffic volume, pcu/h.  
- \( S_{ts} \) —At the beginning of green the straight vehicle saturated flow line, suggestion 3600 puc/m.h.

4.1.2 The calculation of signal timing parameters

1) Cycle time

\[
C_0 = \frac{1.5L + 5}{1 - Y}
\]  

(Ep.11)  

Cycle length should be 40~180s.

2) The total loss of signal, by the following formula:

\[
L = \sum_k (L_s + I - A)_k
\]  

(Ep.12)  

Which:  

- \( L_s \) —Start-up lost time, Should be measured, no data should be 3s;  
- \( A \) —The yellow light time, can set to 3s;  
- \( I \) —Inter-Green Time, s;  
- \( k \) —In a period of interval number.

3) Inter-Green Time, by the following formula:

\[
I = \frac{z}{u_a} + t_s
\]  

(Ep.13)  

Which:  

- \( z \) —distance from the stop line to the conflict, m;  
- \( u_a \) —driving speed in the import, m/s;  
- \( t_s \) —Vehicle braking time, s.  

When computing inter-Green Time I<3s, the yellow light time set to 3s; When I>3s, which 3s is with a yellow light, the rest of the time with the red light.

In the design, Kuanggong road and Kaiyuan road intersection interval time is 3s, the rest of the intersection the interval time is 2s.
4) Volume rate calculation:

\[ \lambda = \frac{q_{dnn}}{S_s} \]  \hspace{1cm} (Ep.14)

- \( \lambda \) — Volume rate
- \( q_{dnn} \) — period of timing, design traffic volume of import m flow direction n, pcu/h;
- \( S_s \) — the design saturated flow, pcu/h;

5) The sum of flow ratio calculation:

\[ Y = \sum_{j=1}^{j_{\text{max}}} \left[ y_j, y'_j, \ldots \right] = \sum_{j=1}^{j_{\text{max}}} \left[ \left( \frac{q_d}{S_s} \right)_j, \left( \frac{q_d}{S_s} \right)'_j, \ldots \right] \quad Y \geq 0.9 \]  \hspace{1cm} (Ep.15)

- \( Y \) — The maximum flow ratio all phase in a cycle \( y_j, y'_j \);
- \( j \) — The number of phase in a cycle;
- \( q_d \) — Design hourly traffic volume, pcu/h;
- \( S_s \) — The design of the saturated flow, pcu/h.

The calculated value is greater than 0.9, it should be improved, or / and signal phase designs scheme, should design again.

6) The total effective green time: The total effective green time of each period is calculated according to the following formula:

\[ G_e = C_0 - L \]  \hspace{1cm} (Ep.16)

7) The phase effective green time is calculated according to the following formula:

\[ g_{ej} = G_e \frac{\max[y_j,y'_j, \ldots]}{Y} \]  \hspace{1cm} (Ep.17)

8) The split ratio of each phase is calculated according to the following formula:

\[ \lambda_j = \frac{g_{ej}}{C_0} \]  \hspace{1cm} (Ep.18)

9) The phase green time: the actual display green time each phase is calculated by the formula.

\[ g_j = g_{ej} - A_j + I_j \]  \hspace{1cm} (Ep.19)

Which: \( I_j \) — No. j phase start-up time loss.

4.1.3 Signal intersection traffic capacity and the degree of saturation

1) A general expression for the capacity

1) The capacity of signalized intersection is according to the interaction imports estimated, with car equivalent units; An import channel capacity is:

\[ CAP = \sum_i CAP_i = \sum_i S_i \lambda_i = \sum_i S_i \left( \frac{g_e}{C} \right)_i \]  \hspace{1cm} (Ep.20)
Which: \( \text{\( CAP_i \)} \) — No. i the entrance lane capacity, \( \text{pcu/h} \);  
\( S_i \) — No. i the entrance lane saturation volume, \( \text{pcu/h} \);  
\( \lambda_i \) — No. i the entrance lane the green ratio belongs to signal;  
\( g_e \) — The effective green time of the signal phase, s;  
\( C \) — Signal cycle length, s.  

2) Straight lane capacity  
\[ \text{\( CAP_T = \lambda S_T \)} \] (Ep.21)  

3) Exclusive left turn lane capacity  
(1) There are exclusive left turn phase:  
\[ \text{\( CAP_L = \lambda S_L \)} \] (Ep.22)  
(2) There are not exclusive left turn phase:  
\[ \text{\( CAP_L = \lambda S_L' \)} \] (Ep.23)  

4) Exclusive right turn lane capacity  
(1) A special phase:  
\[ \text{\( CAP_R = S_R \times \frac{g_e}{C} \)} \] (Ep.24)  
(2) No special phase:  
\[ \text{\( CAP_R = S_R' \times \frac{g_e}{C} \)} \] (Ep.25)  

4) Straight left shared lane capacity  
\[ \text{\( CAP_{TL} = \lambda S_{TL} \)} \] (Ep.26)  

5) Straight right shared lane capacity  
\[ \text{\( CAP_{TR} = \lambda S_{TR} \)} \] (Ep.27)  

6) Straight left and right shared lane capacity  
\[ \text{\( CAP_{TLR} = \min[CAP_{TL}, CAP_{TR}] \)} \] (Ep.28)  

7) Left and right shared lane capacity  
\[ \text{\( CAP_{LR} = \lambda S_{LR} \)} \] (Ep.29)  

8) Saturation level  
Each lane saturation degree is ratio of the each lane actual arrival traffic volume and the lane capacity, that is:  
\[ \text{\( x_i = \frac{q_i}{CAP_i} \)} \] (Ep.30)  

4.1.4 Assessment of the service level  
1. Delay estimation method  
1) The each lane delay may be estimated:  
\[ \text{\( d = d_1 + d_2 + d_3 \)} \] (Ep.31)  
Which:  
\( d \) — Each lane average signal delay, \( \text{s/pcu} \);  
\( d_1 \) — The uniform delay, the vehicle uniform arriving generated delay, \( \text{s/pcu} \);  
\( d_3 \) — The initial queue additional delay, \( \text{s/pcu} \);  
In order to meet the service level requirement, it should not appear in the analysis at the beginning initial queue situation, namely, there shall be no initial queue additional delay, intersection delay is estimated by using the lane:
\[ d = d_1 + d_2 \]  
(\text{Ep.32})

\[ d_1 = 0.5C \frac{(1-\lambda)^2}{1-\min[1,x]\lambda} \]  
(\text{Ep.33})

\[ d_2 = 900T \left[(x-1) + \sqrt{(x-1)^2 + \frac{8ex}{CAP \cdot T}} \right] \]  
(\text{Ep.34})

which: \( C \)—Cycle time, s;
\( \lambda \)—The calculation of the green ratio;
\( x \)—The calculation of the lane saturation degree;
\( CAP \)—The calculation of the lane capacity;
\( T \)—Long duration of time, h, using \( 0.25 \) h;
\( e \)—The correction coefficient of single intersection signal control type, timing

signal using \( e = 0.5 \);

### 4.2. Design of intersection control system

According to the above calculation of single intersection signal timing, the intersection cycle time can obtain as the following table 5.

<table>
<thead>
<tr>
<th>Intersection</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle time</td>
<td>94</td>
<td>110</td>
<td>100</td>
</tr>
</tbody>
</table>

The largest cycle time intersection is the key intersection. Intersection B is the key intersection. Thus cycle time of each intersection is 110s. Every phase can calculate green ratio, green-time and the minimum length of the green light in B intersection, as the following table 6.

<table>
<thead>
<tr>
<th>Relevant data</th>
<th>( I_m ) (s)</th>
<th>( l ) (s)</th>
<th>( C_m ) (s)</th>
<th>( L_m ) (s)</th>
<th>( Y_m )</th>
<th>( g_{sec} ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green light time ( (s) )</td>
<td>2 3 110 840 0.341 0789</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 5. DATA ANALYSIS

#### 5.1 The present data analysis

According to the above formula, the known data calculation can get a series of results. Put the intersection calculation result into attaching list 1,2. According to the analysis of the current situation, some lane saturation are more than 1.0 in these intersections. In addition, current situation intersection signal control delay level of Kuang gong road and Kai yuan road is D.
and Lao dong road is C.current situation intersection signal control delay level of Kuang gong road and Xin hua road is E. So, the only intersection of Kuang gong road and Lao dong road is without re-design, for the rest of the two single point intersection need to optimize. Firstly this paper adjust each intersection canalization.

Table 6 before optimizing and after optimizing

<table>
<thead>
<tr>
<th>Import Lane</th>
<th>Design Traffic</th>
<th>Design Saturated Flow Rate</th>
<th>Flow Ratio</th>
<th>Maximum Phase Flow Ratio</th>
<th>The Sum of the Flow Ratio</th>
<th>The Total Loss of Time L (s)</th>
<th>Current Period C0(s)</th>
<th>The Total Effective Green Time Ge(s)</th>
<th>Effective Green Light Time Ge(s)</th>
<th>Green Ratio λ</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Throug</td>
<td>104 2</td>
<td>1960</td>
<td>0.266</td>
<td>Phase 1: 0.276</td>
<td></td>
<td>12</td>
<td>141</td>
<td>129</td>
<td>50</td>
<td>0.388</td>
</tr>
<tr>
<td>West Throug</td>
<td>108 1</td>
<td>1960</td>
<td>0.276</td>
<td>Phase 2: 0.175</td>
<td></td>
<td>0.824</td>
<td></td>
<td>129</td>
<td>24</td>
<td>0.186</td>
</tr>
<tr>
<td>South Shrai</td>
<td>409 1</td>
<td>1892</td>
<td>0.216</td>
<td>Phase 3: 0.216</td>
<td></td>
<td>12</td>
<td>141</td>
<td>129</td>
<td>25</td>
<td>0.194</td>
</tr>
<tr>
<td>North Throu</td>
<td>242 1</td>
<td>1960</td>
<td>0.124</td>
<td>Phase 4: 0.159</td>
<td></td>
<td>12</td>
<td>141</td>
<td>129</td>
<td>30</td>
<td>0.233</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Import Lane</th>
<th>Design Traffic</th>
<th>Design Saturated Flow Rate</th>
<th>Flow Ratio</th>
<th>Maximum Phase Flow Ratio</th>
<th>The Sum of the Flow Ratio</th>
<th>The Total Loss of Time L (s)</th>
<th>Current Period C0(s)</th>
<th>The Total Effective Green Time Ge(s)</th>
<th>Effective Green Light Time Ge(s)</th>
<th>Green Ratio λ</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Throug</td>
<td>104 2</td>
<td>1960</td>
<td>0.266</td>
<td>Phase 1: 0.276</td>
<td></td>
<td>0.734</td>
<td>12</td>
<td>141</td>
<td>30</td>
<td>0.344</td>
</tr>
</tbody>
</table>
This paper takes the Kuang gong road and Kai yuan road as the test example.

1) Kuang gong road and Kai yuan road:

It can be seen from attached list 2, in south imported saturation degree of straight right shared lane is 1.198, which is more than 1.0. So the paper increases one lane in the south entrance, and puts the original straight right shared lane to straight right separation lane, to decrease maximum flow ratio of the third phase. Specific adjustments are as follows:

<table>
<thead>
<tr>
<th></th>
<th>right</th>
<th>1</th>
<th>1519</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>through</td>
<td>108</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>288</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>right</td>
<td>378</td>
<td>1</td>
</tr>
<tr>
<td>South</td>
<td>through</td>
<td>409</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>281</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>right</td>
<td>123</td>
<td>1</td>
</tr>
<tr>
<td>North</td>
<td>through</td>
<td>148</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>266</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>right</td>
<td>284</td>
<td>1</td>
</tr>
</tbody>
</table>

2) Kuang guang road and Xin hua road

According to above, the first phase of the maximum flow ratio is the west direction straight lane, which is 0.341. It should decrease the maximum flow rate in this phase. But saturation level is 0.840, which is less than 1.0, this lane does not change canalization. North import straight lane saturation level is 1.323, which is more than 1.0. So, north direction increase a lane. Specific adjustments are as follows:

Figure 3 Kang gong road and Kaiyuan road intersection canalization design
5.2 Comparison of the present situation and linear control design

1) Kuang gong road and Kai yuan road simulation picture

The chart can make out the queue length which is longer in the Kai yuan road. After finishing linear control design, in north direction the queue length of straight vehicles reduce. And the main road-Kuang gong road delay cut down.

2) Kuang gang road and Lao dong road simulation picture
This paper does not change single intersection signal timing design, but this intersection make use of the linear control design. The above picture can make out that the delay of the main roads decrease.

3) Kuang gang road and Xin hua road
4) The each intersection contrast delay time before and after optimization

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Imports</th>
<th>The present delay time (s)</th>
<th>Delay time after optimization (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuang gong road-Kai yuan road</td>
<td>East direction</td>
<td>40.903</td>
<td>31.697</td>
</tr>
<tr>
<td></td>
<td>West direction</td>
<td>46.242</td>
<td>31.107</td>
</tr>
<tr>
<td></td>
<td>South direction</td>
<td>63.456</td>
<td>45.501</td>
</tr>
<tr>
<td></td>
<td>North direction</td>
<td>62.315</td>
<td>38.216</td>
</tr>
<tr>
<td>Kuang gong road-Lao dong road</td>
<td>East direction</td>
<td>25.381</td>
<td>25.381</td>
</tr>
<tr>
<td></td>
<td>West direction</td>
<td>25.970</td>
<td>25.970</td>
</tr>
<tr>
<td></td>
<td>South direction</td>
<td>58.308</td>
<td>58.308</td>
</tr>
<tr>
<td></td>
<td>North direction</td>
<td>46.583</td>
<td>46.583</td>
</tr>
<tr>
<td>Kuang gong road-Xin hua road</td>
<td>East direction</td>
<td>109.240</td>
<td>80.23</td>
</tr>
<tr>
<td></td>
<td>West direction</td>
<td>139.899</td>
<td>36.389</td>
</tr>
<tr>
<td></td>
<td>South direction</td>
<td>51.754</td>
<td>35.123</td>
</tr>
<tr>
<td></td>
<td>North direction</td>
<td>28.848</td>
<td>38.194</td>
</tr>
</tbody>
</table>

Form the above table, the linear control can obviously reduce the delay time.

6. CONCLUSION AND DISCUSSION

Form the above chart and table, the linear control approach can play a good role in arterial signal timing optimization, which can reduce the number of parking, reduce delay and congestion situation on the road. It plays an important role to achieve the smooth traffic flow for the main road and improve the urban traffic conditions. Intersection delay reduces 5%~25%, the stopping number decreases 10%~24%, this can effectively improve the main road traffic running state in the city. But pattern of the signal control has many species. Therefore it has more work in optimizing road network species. In addition, the non-saturation situation should be considered in the future study.

REFERENCES


