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# Optimize Traffic Police Arrangement in Easy Congested Area Based on Improved Particle Swarm Optimization

Ningyu Zhao, Zhiheng Li*

*Department of Automation, Tsinghua National Laboratory for Information Science and Technoligy(TNList), Tsinghua University, Haidian District, Beijing 100086, P.R. China*

**Abstract**

In order to ease the traffic jams in easy congested area, it needs to arrange some traffic policemen to direct the traffic in the congested intersections. Aiming at letting the traffic policemen arrive at the congested intersections quickly, the model of arranging the traffic police is established. This model is a complex optimization problem so it is solved by an intelligent optimization algorithm, Particle Swarm Optimization Algorithm. A little change is given to the algorithm so that it is more suitable for the model. Also the process of solving the model with improved Particle Swarm Optimization is given. This model can work out the optimal positions of the traffic police kiosks and the number of policemen in each police kiosk, so the best plan of arranging the police in the easy congested area is acquired. It proves that using this method to arrange the traffic police in the easy congested area can ensure the policemen arriving at the congested intersections in minimum time, preventing the congestion or the spreading of the congestion as soon as possible.



*Keywords:* traffice congestion; traffic police; easy congested area; arrengement plan; PSO

## 1. Introduction

Nowadays, traffic congestion has been a serious social problem, which restricts the development of the economy. Wu, Chen, Huang and Hu (2011) showed that England lost fifteen billion pounds because of the traffic congestion every year. America lost 63 billion dollars due to the traffic jams. In China, the city of Beijing lost 44 billion yuan a

* Corresponding author. Tel.: +86-156-5291-8492.
*E-mail address*: zhhli@tsinghua.edu.cn


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year. So we should try the best to control the traffic congestion. When the urban traffic congestion happens, there are many methods to ease it, such as traffic guidance, traffic signal control, congestion charge and so on. All of these methods are useful to control the urban traffic congestion but all of them have the same shortcoming, that is, when the urban traffic congestion is very serious and the traffic breaks down, all of these methods can't work. At this time, only the traffic policemen can direct the traffic and make the traffic return to normal.

Different from the other traffic congestion controlled methods, the traffic policemen stay in the police station or the police kiosk, which may be far from the congested place. When serious urban traffic congestion happens, traffic policemen must reach the congested place as soon as possible, preventing the spreading of congestion. In order to ensure that the traffic policemen can arrive at the congested place in a limited time, some traffic police kiosks should be built in the easy congested area for the traffic policemen to stay. So where are the reasonable places to build the traffic police kiosks and how many policemen are arranged in each traffic police kiosk are two useful problems, which need to be discussed. There were some researches about how to arrange the police. Zhang (2006) gave some principles of the distribution of police resources but he did not give the model. Guo and Ma (2008) gave the olive mode of the police deployment but their method was only useful for large area's police arrangement. Zhu and Jiang (2010) did some researches on the traffic police's disposing but they focused on the traffic emergency, not the traffic congestion. Fu et al. (2012) discussed the dispatch of the traffic police but they did not consider the optimal starting places. Above all, this paper studies the model of arranging the traffic police kiosks and the traffic policemen in the easy congested area. The model ensures that the traffic policemen can reach the congested place quickly. The established model is complex and difficult to solve, so this paper chooses a new intelligent optimization algorithm, Particle Swarm Optimization (Eberhart and Kennedy, 1995), to solve this model. Meanwhile this paper changes a little of this algorithm to obtain the improved Particle Swarm Optimization, making it more suitable for the model. Fortunately, with a numerical example this paper shows that the improved Particle Swarm Optimization works well on this model. It can give an optimal plan about arranging the traffic police in an easy congested area.

The paper is organized as follows. The model of the traffic police arrangement is introduced in section 2. Then the introduction of the Particle Swarm Optimization and the process of solving the model are presented in section 3. Section 4 calculates an example, giving the plan about the arrangement of the traffic police. Section 5 concludes this paper.

## 2. The model of the traffic police arrangement

Suppose there is an easy congested area that has $n$ intersections and the intersections is connected by the roads. The $i$th intersection is $x_i$. This easy congested area needs to build $m$ traffic police kiosks. The $j$th traffic police kiosk is built at position $y_j$. There are $p_j$ policemen staying in the $j$th traffic police kiosk. Our aim is to find the $y_j$ and $p_j$ so that when either of the intersections becomes congested there is a policeman can reach this intersection in minimum time. Here are some hypotheses about this problem.

- The urban traffic congestion happens only in the intersections. The traffic policemen only need to go to the intersections to handle the congestion.
- The traffic police kiosks only can be built next to the road. Any place far from the road is not suitable for traffic kiosks. There are enough policemen to handle the traffic congestion.
- The time that a traffic policeman goes from the traffic police kiosk to the congested intersection is only related to the distance of these two places. The traffic congestion can't influence the traffic policeman because he can ride a motorcycle or use the emergency lane.

According to these hypotheses this paper sets up the model of the traffic police arrangement. The model is introduced below. The form of some symbols is as follows.

$$X = \{ x_1 , x_2 , \dots , x_i , \dots , x_n \} \tag{1}$$

$$Y = \{ y_1 , y_2 , \dots , y_i , \dots , y_m \} \tag{2}$$

$$y_j = (a, b, c) \tag{3}$$