OD-Matrix Estimation for Urban Traffic Area Control

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ABSTRACT
Congestion, accidents, greenhouse gas emission and others seem to become unsolvable challenges for all levels of management in modern worldwide large cities. The increasing dynamics of motorization requires development of innovative methodological tools and technical devices to cope with problems appeared on the road networks. Primarily, control system for urban traffic area has to be created to support decision makers via operating with big transportation data. The input for a such system is a volume of travel demand between origins and destinations – OD-matrix. The present work is devoted to the problem of OD-matrix estimation. The original technique of plate scanning sensors location is offered. The developed method has been tested on the experimental parameters of the Saint-Petersburg road network.

1. INTRODUCTION
The problems of estimation and reconstruction of trip matrices are difficult and actual problems in transportation researches. In general, trip matrices estimation and reconstruction are different problems and their solutions can be unequal [1]. One of the first mathematical models of a trip matrix estimation developed in the end of XX century was formulated as a bi-level program [2]. Despite numerous publications, this problem is still pressing scientific issue that requires further research [8]. Among the recent results in this area the paper [3] should be mentioned, since in this article authors consider the problem of trip matrix and path flow reconstruction and estimation by combining data from article authors consider the problem of trip matrix estimation. The original technique of plate scanning sensors location is offered. The developed method has been tested on the experimental parameters of the Saint-Petersburg road network.

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anteed by the following constraint:
\[
\sum_{a \in A} q^k_a \delta_{k_1 k_2} \geq 1 \quad \forall k_1, k_2 \in K, k_1 \neq k_2,
\]  
(3)

\[
\delta_{k_1 k_2} = \begin{cases} 
1, & \text{if } a \in k_1, a \notin k_2, \\
0, & \text{otherwise}. 
\end{cases}
\]  
(4)

Consider the budget constraint, where \(Q\) — the number of available sensors:
\[
\sum_{a \in A} q_a \leq Q.
\]  
(5)

The number of sensors on the arc should not exceed the number of lanes:
\[
0 \leq q_a \leq c_a, \quad \forall a \in A.
\]

So, we formulated the integer program on a limited set of solutions. The solution of this problem exists when the set of possible solutions is not empty.

3. COMPUTATIONAL EXPERIMENT

Consider a multi-lane traffic network of Saint-Petersburg city center. We define nine areas of origin-destination (fig. 1), nine routes between pairs of origins and destinations and, hence, 21 arcs (fig. 2).

We define the number of lanes \(c_a\) and \(a\) priori traffic flows \(\bar{f}_k\) on the available routes. Then we calculate optimal plate scanning sensors location for the different budget constraints varying budget values from 0 to 50. Since there is the optimization problem with nonlinear functional and linear constraints, we employ \textit{fmincon}-function in a software environment MatLab. The dependence between the observed flows value and the number of sensors located on the network are presented on the fig. 3.

![Figure 1: Origins-destinations](image1)

![Figure 2: Links](image2)

![Figure 3: Total flow](image3)

![Figure 4: Combinations of restrictions](image4)

Conclusion
The article is devoted to the problem of optimal location of traffic plate scanning sensors on the network. A brief review of the literature is carried out and the method of Castillo is recognized. To increase the efficiency of the Castillo method, an original model of optimal location of plate scanning sensors on the network of general topology is developed. The developed model allows to maximize probability of identification of the most significant traffic flows throughout the corresponding routes. We obtained the following theoretical and practical results:

- a deterministic model of optimal plate scanning location on the network of general topology;
- an algorithm for solving deterministic problem of the sensors location;
• implementation of developed algorithm on the transport network of St. Petersburg.

4. REFERENCES


