AGENTs APPROACH IN SMART MANAGEMENT OF URBAN TRAFFIC CONTROL

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ABSTRACT
Urban population is increasing but urban transportation infrastructures have not developed in conformity with this increase which leads to high ingestion in streets. The most applied approach for solving this problem is efficient use of these infrastructures and efficient use of traffic has important role in this efficiency. Purpose of this research is presenting a factor-oriented system for controlling urban traffic control. Traffic control system can hardly have a complete and correct view of traffic in network because of distributing urban traffic along with urban transportation network and its rapid fluctuations. This needs installing sensors throughout network and sending to one center which has great cost. Therefore, agents should be able to decide regarding local information from observed area. This decision making should be in respect of meeting general purpose which is optimized traffic control. Regarding limitations, traffic control problem is modeled as resources reactive control problem. In this approach, a criterion is selected for digitalizing transportation resources shortage i.e. streets. Traffic control agent is always seeks to create desired changes; for this reason, it continues action which causes desired change and stops undesired change action. The presented approach is a simple way for environment dynamic abstraction and with aligning resources under control of agents provides implied harmony and activity.

Keywords: Smart Management, Urban Traffic Control, Agents, Urban Transportation.

INTRODUCTION
Urbanization, increase in using personal vehicles for transportation and lack of urban transportation infrastructures have increased urban travels and caused people spend more time in streets' congestion, length of cars' queue increase, air become more and more polluted and urban life is accompanied with reducing clean air, noise pollution and wasting time (Deakin, 2003).

There are three approaches for this problem: 1) obligatory migration of urban residents; 2) developing urban transportation infrastructures; 3) better exploitation of current infrastructures. First approach is elimination of problem, if we don't say that it is irrational. Second approach is vital but it is full of difficulty and cost in densely populated areas. Third approach seems easier and it means that by improving use of infrastructures we can improve traffic quality. One of urban planning duties is improvement in using urban roads. This planning has two aspects, one is strategic planning for road and the other is controlling traffic regarding network traffic condition. From what has said, we can understand that correct control of urban traffic is one way to improve life condition in cities (Goldman and Roger, 2006; Kennedy et al., 2005). One of urban managers' challenges is finding solution for managing urban traffic. They should determine that control should be automatic or manual?

Main step in solving each problem is choosing between manual or automatic implementation. In this step, engineers always pose characteristics like lack of fatigue, reducing costs, high speed and etc. in automatic systems and enumerate characteristics like low speed, high cost, depending efficiency to human mood and etc. in manual systems and reject it.

Traffic is a dynamic set of different agents like man, automobile, road, weather condition and etc. Man's presence in an environment that we always deal with a creature which is always making decisions, changing mind and generally changing being which adds high dynamism to environment. This dynamism
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reduces safety of environment and creates an unsafe context for decision making and action. No element of environment remains in dynamic environments unless it has flexibility against environment changes or it can resist against it. Only being or trend can have second characteristics which was omniscient i.e. it can predict infinite future and plans based on it; therefore, considering human knowledge, flexibility is better option. Flexibility means that a being or trend shows desired reaction to changes and this reaction is seen with changing behavior or idea (Yaqoobi et al., 2012).

MATERIALS AND METHODS
This is an analytical-comparative research which is done by library-documents method such that in data gathering part, main part is conducted through field observations and referral to some offices and organizations like city hall, road and city building office; therefore, researcher has used descriptive and documentary analysis for this research.

Theoretical Foundation of Research
Software operator concept is rooted in multi-operator systems which these systems are in turn one of three common discussions in distributed artificial intelligence i.e. parallel artificial intelligence is solving delivered problem and multi-factored systems (Nwana and Wooldridge, 1996). Therefore, it is clear that it inherits capabilities of distributed artificial intelligence systems. For example, findings details speed and high reliability which is product of calculations distribution and inherits capabilities like processing in knowledge level, easier maintenance and re-uses which is product of artificial intelligence (Jennings & Wooldridge, 1996). Agent concept has emerged early in 1970s. At the time, how it has introduced "concurrent objects" (Hewitt, 1977). In his model, concept of autonomous, interactive and concurrent implementation was presented that he called them actor. Each object has internal states and its relation with other objects was through sending message. According to him, an actor is a computing agent which has behavior and address. Agents communicate with each other by sending message and interact in concurrent manner (Litman and Burwell, 2006; Loo and Chow, 2006). There is no unified definition for agent and each scholar presents a definition based on his view. Therefore, agent important definitions from scientists and researchers' point of view are presented here: Russell and Norvig: agent is a thing which understands its environment with sensors and influences in environment with actors. This definition is heavily dependent on environment (Russell and Norvig, 1995). Mass: agent is a computing system which inhabits in a dynamic and complex environment, feels environment autonomously and form actions regarding its purpose. Mass is one of pioneers in agent researches. He emphasized in agent definition that agent should be able to work alone to meet some purposes. Also he limits agent environment to complex and dynamic environment (Maes, 1995). Smith: agent is permanent software which is designed for certain purpose. Permanence of agent distinguishes it from subprogram and makes it purpose-specific (Smith et al., 1994).

Intelligent Agent Architecture

Figure 1: General Structure of the agent architecture thinker
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Most innovations in intelligent planning are done by AI planning association. They believe that planning is indispensable part of every intelligent system. Because this architecture uses three structures belief, desire and intention in its planning process, this architecture is called BDI. Figure (1) shows internal structure of these architectures in which beliefs are environment facts, desires are agent objectives and intention is current objective of agent (Jennings and Wooldridge, 1995).

Traffic: increasing development of cities has transformed man and commodity displacing to a daily problem which its complexity is increasing. Urban development increases demand for transportation infrastructures which are streets (Zareeian et al., 2012). Two approaches exist to smooth urban traffic: 1) Developing infrastructures; 2) efficient and maximum use of these limited resources (streets) (Chrobok et al., 2000).

First approach needs much time and cost and it is not feasible in some areas; therefore, second approach is considered i.e. correct use of existing resources. Manner of using resources is determined by traffic control. Traffic control should allocate resources to transportation needs and monitoring its accuracy (Shiftan et al., 2003).

Traffic Parameters: in order to control traffic, we should know that with which parameters traffic should be measured? What is the relationship of these parameters? Which behaviors in parameters make traffic control harder? And can traffic be controlled optimally by having set of traffic control parameters?

Definition of Condition Parameters and Traffic Control: flow rate: number of passing cars in time. Flow rate: amount of distance traveled by traffic in time unit. Occupy: percent of time that one point of road is occupied by one vehicle.

Density: number of vehicle in distance unit in time. Progression time between vehicles: time interval between a vehicle and next vehicle. Phase: states of traffic light in a street. Cycle: sum of all Phase's time; sector: time that red or green light is on; offset: time distance between two junctions (Chrobok et al., 2000).

Traffic Control: traffic control can be direct and indirect. Direct control is traffic lights, boards and signs that driver should follow them. Indirect controls are signs which have only guiding aspect. Most traffic systems control direct control signals i.e. traffic lights (Zareeian et al., 2012). Generally, there are two signal control mechanisms: 1. Separated signal, 2-connected signals.

Spatial distribution of urban roads has emerged various applications of agents in urban traffic. Agent’s application in urban traffic can be divided into three groups:

1. Agent for traffic to control
2. Agent for traffic simulation
3. Agent for traffic information (Yigitcanlar et al., 2008).

Most reported applications in literature are developing or trial systems. Reviewing them provides understanding with use capacity of agent to improve efficiency of transportation. Rosemond proposed developing an urban traffic control system based on agent who reacts against environment changes and its parameters are controlled regarding travel demand, traffic flow and modifications in environment. Architecture of this system is based on crossed agents (local controller) and regional agents (cross section controller).

Regional agents in network should have the duty of harmony in order to optimize network (Roozemond, 2012).

Kockla et al., has suggested development of passenger flow microscopic simulator using factors. Authors believe that after software accuracy test, this software can help in designing pavements and public spaces (Kukla et al., 2001).

Other research report developing smart agent based on knowledge for traffic control. In these researches, road network is divided to different areas that each agent should control its area (Hernandez, 1999).

In a hierarchal architecture, in addition to areas’ factors, some harmonizing agents are considered to resolve control interventions.

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RESULTS AND DISCUSSION

Distributed Traffic Control Systems: distributed systems are those systems in which controller should decide about junction control. Of course, it can communicate with other controllers. Distributed traffic control systems have these characteristics:
1- Rely on local control power;
2- Are inherently sustainable in line;
3- Tier development is easier than concentrated systems;
4- They are cheaper because of low networking;
5- Have not comprehensive view from network and cannot run optimization algorithms.

Commercial Traffic Control Systems: in this part, we examine two known traffic control systems and their characteristics.

SCOOT: is the first commercial traffic control system. SCOOT has shaped in late 1970s and early 1980s in Britain's transportation research laboratory. SCOOT is a concentrated system and optimizes in three levels: sector, offset and cycle. (Green sector shows light of each street. Offset shows time interval between two crosses which is considered for neighbor junctions and cycle specifies pass order).

In order to install SCOOT in an urban network, required parameters should be determined and calibrated such that SCOOT model can work properly in environment. SCOOT uses a concentrated algorithm in which connection of one load in a second with all node control is necessary. Therefore, SCOOT is completely dependent on network connections and central computer.

SCATS: was developed by New South Wales traffic office in Australia and uses distributed hierarchal architecture with three levels. This architecture consists of monitoring computer in center of traffic control, regional controllers and local signal controllers. Central monitoring computer gives access to traffic data. Monitoring computer runs following works without intervention in traffic control:
1. Investigating traffic condition and equipment’s to correct error;
2. Reports traffic data for short-term or long-term documentation;
3. Backups regional controller to load it if necessary;
4. Allows traffic control center to monitor systems, subsystems or junctions, changes control parameters or changes control from automatic to manual (Zareeian et al., 2012).

Each regional controller autonomously controls areas' junctions. These controls are SCATS' heart and usually controlled by traffic center to reduce connection cost. They take decisions related to signals by analyzing data which are processed by microprocessors. Junction controllers process sensor data and send them to regional controller.

Evaluating Current Commercial Systems: concentrated systems has a great problem i.e. single point of failure” but a problem which is introduced in both systems is their intense need to calibrating required parameters for correct model of urban traffic which should be specified by user considering network condition with trial and error. Some of their disadvantages are:

Great cost (time, finance), sensors and controllers' networking, parameters' calibration cost, severe damage to system integrity in the case of error in communication lines and disrupting system in failure of central system computers. These systems need a comprehensive picture of network traffic or part of it for desired control (Zietsman and Laurence, 2002).

Urban Traffic Problem Relation with Common Problems in other Sciences: one of interesting features of urban traffic is presented approaches by different sciences' scholars. Investigating traffic texts shows that each researcher tried to create an abstraction from traffic flow to resemble one of problems in their science so that he can provide a new analysis. These abstractions are run in three levels fine grain, average green and coarse grain. Table (1) lists some of these tries (Hoogendoorn and Bovy, 2000).
Now this question arises that “if we have problems like traffic in computer sciences? And can we use applied methods in these issues for urban traffic control? Perhaps in first look, the most similar topic in computer sciences is computer networks traffic but can we use techniques in computer network traffic in urban traffic problem (like managing congestion and etc.).? However, in the first look urban traffic and computer network traffic have similarities including presence of communication infrastructure in both of them (in computer networks: network connection and in urban networks: streets and mobile elements). In computer networks packages and in urban networks, vehicles and topology representation capability is expressed as a graph but there have natural differences which necessitates differentiation of these two issues:

1. In computer networks, destination of packages is clear but in urban traffic, because of instant decision making of driver, destination is not clear.
2. In computer networks, router determine next path for package movement but in urban network, controller cannot and should not force driver to change direction.
3. In computer networks, in the case of congestion and full buffers, additional packages were eliminated and sender resends them.

But in urban traffic network, vehicles will be remain on their place in the case of congestion and in the lack of correct management of congestion, extends congestion to other points of network. Regarding what has been said, although computer networks have structural similarity with urban traffic network but they have important differences. Many research activities on robots and control systems are shared and run to...
decrease implementation costs. From what has said, we can understand that current objectives of control systems (flexibility and autonomy) are the concept of flexible agents which satisfy these objectives; therefore, agents have important role in control systems (Hoogendoorn and Bovy, 2000). We can summarize rationale of research as following: in correct allocation of resources shortage of each resource should be understood by decision-maker. Then it meets demands. Market method acts through bid but in mentioned method, agent acts as below: amount of each resource shortage is measured by cost and reduced to a number; understanding: changing occupation or freedom trend cost and comparing price of framed resources for correct understanding of environment for factor; meeting needs: is done greedily to prevent undesired changes; real need: with price function characteristics that in larger prices has higher changers and considering price changes as a scale, instead of price to measure real need with price and trend change.

Findings can be expressed as following:
- Agent should compromise between observation sensitivity and ease in observation depending on operational context.
- The more monotonous context, agent observation sensitivity increases.
- In variant contexts, observation ease agent should show more observations.

Way Forward: We divide it into agent and traffic branches:

A. Factors
- In which environment we can use similar methods? What characteristics these environments should have? Can we determine these environments with a scale? Can we establish a method for determining criteria and its control?
- Can we improve greedy method by adding another criteria or process and optimized them?
- Can we conform proposed method to optimized control? If yes, where and if no, can we approximate its distance?
- Can we obtain a criterion for sensitivity and ease in observation regarding environment dynamism?

B. Traffic
- Finding an efficient method to determine mean speed in a street, using history and combination of sensor data are useful.
- Defining other price relations and their role in different traffic parameters.

Conclusion
This study suggests a new approach for traffic control using kinds of resource allocation. This distinction preserves environment dynamism and provides a ground for traffic control.

In order to control traffic, changes caused by control decisions divide into two desired and undesired changes. Traffic control agent always continues effective interactions in desired changes and prevents actions with undesired changes. Proposed control method is easy and efficient and performance simulation results show its better performance in respect to timing traffic lights.

Traffic control issue was hurt by a relatively complex method and it is hurt because we cannot claim that it imposes optimized control on urban traffic but tries to greedily react to environment changes without retrospection.

This method has advantages and disadvantages:

Advantages
- Network dynamism changes to digit with price function and effective agents on decision making reduce to one factor.
- System works well with every condition and there is nothing as unexpected event which disturbs decision making in intelligent systems and this is because in usual systems, there is a program for each state of system. Now if system state changes to unknown state caused by unexpected event, system cannot control it while in proposed method there is no predetermined state.
- Price changes show traffic propagation in network.
- Traffic control agent can work in non-homogenous environments like network of preplanned junctions.
Resetting agent will not hurt its performance but if determined strategy loses its efficiency because of behavioral change, it’s resetting leads to selecting better strategy. Developing intelligent urban traffic control can be increasing or trivial.

Agents harmony with each other implicitly or through observing changes in common context. It is a simple approach for traffic.

Disadvantages
- Two agents mean current speed and mean of maximum desired speed will not obtain by modern controllers.
- We have no claim about its optimization, but we can say that scheduled method with fixed time is better.

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REFERENCES


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