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INTELLIGENT ELECTRIC SYSTEMS IN URBAN TRAFFIC CONTROL

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Summary. The intelligent electric systems for urban traffic control have been presented in the present paper. The road traffic detector and its role in traffic control system have also been characterized. Furthermore the intelligent transport system and its role in urban communication as well as SCATS (Sydney Coordinated Adaptive Traffic System) have been discussed.

Key words: intelligent electric systems, road traffic, urban orientation systems, traffic control system

INTRODUCTION

The concept associated with intelligent building systems and so called intelligent installations became popular and increasingly present in our every day's life in recent years. Those subjects are also present in road traffic. The development of intelligent electric systems for urban traffic control resulted mainly from continuously increasing number of motor cars.

Owing to the fact that physical expansion of transport systems is limited, the alternative methods are necessary to improve traffic conditions. The intelligent systems for urban traffic control are installed as one of proposed solutions in that scope.

The application of modern IT networks for urban traffic monitoring and control is another method used to improve the motor transport in large urban agglomerations and industrial centres.

Road traffic detectors as the devices used for the detection of the presence (traffic) of vehicles at precisely determined measuring points, are an extremely important element of the urban traffic control system. The intelligent road consists of radio-electronic detectors network transferring the data to the server in real time. The detectors are installed along the road in order to ensure the scanning of traffic stream and to transmit its parameters at proper time i.e. stream velocity, its intensity and quantity of transport means. The transport means may be subdivided into categories e.g. motor cars, small and big trucks and long vehicles.

Road traffic is controlled by means of traffic lights and specially controlled traffic signs. In case of any traffic impediments recorded by the road detectors in any street from among the streets adhering to the trunk highway, the existing traffic scheme will be automatically modified by means of traffic signs to reduce the number of vehicles arriving in the traffic jam area.

Every urban traffic control system is designed for realization of determined road traffic model. The latter is developed as the result obtained from the vehicles traffic intensity studies. The traffic control system called START and applied as experimental system in Moscow designed for large agglomeration can be presented as an example. Its operation principle consists in signalling control carried out on the basis of traffic volume and average traffic route velocity data received from the „collecting" cameras. The purpose of that system is to facilitate the elimination of traffic jams, particularly in the vicinity of hypermarkets and on the road leading to the airport.

THE FIRST INTELLIGENT ELECTRIC SYSTEMS

The initial improvements in the road traffic management consisted in the attempts to reduce time losses of vehicles through signals coordination on the road crossings sequences and through the designing of control devices with functions depending on current situation on the road crossing. As early as in 1922, the first control system for road crossings group in Houston (USA) and the first coordination system for road crossings sequence in Salt Lake City were introduced. By the end of the 1940s similar systems were introduced in the central parts of all large cities in the USA.

An introduction of devices recognized as the original versions of traffic controllers was another direction of traffic control development. Microphones were installed in two American towns i.e. New Heaven and Baltimore in 1928 as the detectors allowing to pass through road intersection with the main road for the vehicles after their arrival announcement by means of motor horn.

The invention in form of traffic controllers integrated with mechanical and pneumatic detectors was the next development phase. The first pedestrian traffic lights were installed in Paris in 1933. The traffic control systems were generally applied in the United Kingdom later and traffic controllers were provided at about 85% of British road crossings in the 1960s.

The first microprocessor local controllers were introduced by Philips in 1975. Except of traffic lights control, their functions encompassed also traffic data processing and direct use of traffic data for traffic control. The minimization of the number of cable connections between local and superordinated level was possible by means of modern serial transmission systems [Jamroz 1984].

ROAD TRAFFIC DETECTORS AND THEIR ROLE IN TRAFFIC CONTROL SYSTEM

The role of detection systems used for the detection of vehicles presence and the number of vehicles travelling across designated area is very important in traffic control systems. Another purpose of detection system is to record the weather data and road accidents data. The introduction of speed limitations using the signs with variable con-

tent or informatory signs (detours) is also possible to ensure undisturbed traffic and safety in case of high traffic volume.

The essential functions of road traffic detectors are:

– optimisation of traffic lights control for the road crossings and pedestrians crossings,
– creation of traffic database and road traffic changes monitoring in order to implement proper control and management modifications,
– data acquisition at locations for which early detection of traffic disturbances and road accidents is necessary to ensure the safety of road traffic participants,
– traffic monitoring and regulation for entry slip roads and highways approach sections
– identification of „demands" for right of way by monitoring of the vehicles using special traffic lanes and by monitoring of special vehicles, for instance ambulance and fire department vehicles;
– control of entry into parking areas; determination of parking areas occupancy level;
– information display (on signalling devices with variable content) for road traffic participants, e.g. excessive speed, insufficient distance between vehicles or excessive height of a vehicle;
– traffic data acquisition for bicycle tracks or for traffic lanes to be used by buses exclusively,
– optimisation of vehicles queues length for the locations where the traffic can be disturbed or its safety can be endangered by the queues,
– identification of vehicles type, for instance the measurement of their weight or other parameters characterizing the vehicle including the use of video recording techniques.

INTELLIGENT TRANSPORT SYSTEMS

The Intelligent Transport Systems (ITS) have been developed in connection with increasing needs of the passengers demanding more and more efficient functioning of urban transport systems. ITS consist of a group of innovative tools created on the basis of information technology, wireless communication and automotive electronic solutions. Owing to the access to information on current conditions in city traffic in real time, the competent authorities as well as transport services and the passengers are better informed and therefore are able to make the optimal decisions in the field of transport. The Intelligent Transport Systems (ITS) may contribute to an improvement in urban transport. They increase the comfort of driver's work and travel comfort for passengers as well as reduce its negative impact on the environment.

Using the wireless communication, positioning systems and continuous data updating, the passengers have permanent access to buses departure times information in real time. Every bus stop integrated by the system, except of conventional timetable, is provided with lighting panel displaying the real times of buses departures. Such information is available to the passengers before leaving home. Furthermore, the information on the real times of buses departures is accessible in mobile phones via WAP and in the Internet. The buses are also provided with lighting panels displaying the name of the next bus stop and numbers of buses and trams, which may be taken later as well as their real departure times. Thanks to such facilities, the passengers are really able to plan their travel because they have sufficient amount of information [Szlachta…].

INTEGRATED TRAFFIC MANAGEMENT SYSTEM

Owing to the large number of objectives (very often excluding each other) to be accomplished by road traffic control systems, especially designated systems are applied in order to achieve the selected group of objectives.

The Integrated Traffic Management System is defined as a set of methods and means designed for operative action on the traffic on the basis of information on current condition of the traffic and environment.

The purpose of Traffic Management System is to ensure optimal passengers and goods movement in the area encompassed with that system. The system consists of partial systems characterized by diversified degree of its impact on the traffic and information acquisition.

SCATS SYSTEM

SCATS (Sydney Coordinated Adaptive Traffic) belong to the third generation systems ensuring adaptive urban traffic control in real time. The system performs traffic parameters analysis on ongoing basis to control the length of cycles, phases and offsets in the traffic light controllers subordinated to that system. Using the data originating from the traffic detectors (induction loops, cameras etc.) and complex calculation algorithms, the traffic lights are controlled automatically, maximizing the roads capacity, reducing the delays and the number of stoppages.

The client – server technology in Windows NT environment has been applied in SCATS system. Two servers are used [TYCO…]:

– regional SCATS server ensuring the adaptive traffic control functions within a large area and communication with maximum 250 controllers associated with traffic lights,

– central SCATS (SCATS CM) manager – ensuring central access, database, entry and setting as well as priorities in various SCATS regions.

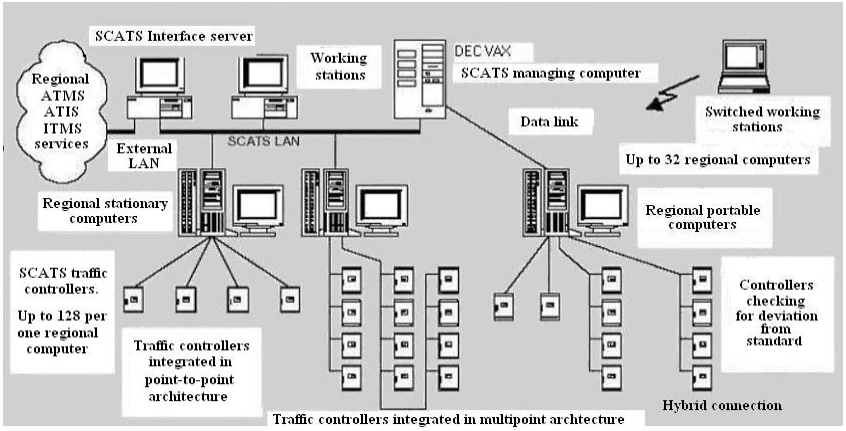

Fig. 1. The architecture of SCATS system with integrated server

The architecture of SCATS system is illustrated in Figure 1. Up to 64 regions may be supervised and the operation of up to 16 000 road crossings may be controlled by SCATS system. More than 3000 road crossings are controlled by means of SCATS system in Sydney (Australia). The working stations of the operators use the clients' program enabling the connection by means of LAN, WAN networks, phone of GSM mobile telephony service [TYCO…].

TETRA AS AN EXAMPLE OF URBAN COMMUNICATION SYSTEMS

TETRA (Terrestrial European Trunked Radio) as an integrated communication system was designed as an open standard of digital mobile communication combining the advantages of conventional radiotelephony, mobile telephony, message and data transmission and enabling the functioning of the environment with many hardware and systems suppliers and enabling immediate contact with one, ten or even hundred members of the team.

Fig. 2. TETRA integrated system [TETRA Compact]

The main functions of TETRA standard (Fig. 2) are:

– mobile communication with the mobile and stationary subscribers,
– electronic mail (E-mail),
– transmission of short text messages,
– operation in full duplex/semi-duplex mode in the scope of telecommunication, radiotelephony and dedicated communication service,
– wireless monitoring and remote control functions.

CONCLUSIONS

On the basis of the considerations presented above, the following conclusions can be drawn:

1. At the moment, the integration of the following existing systems is the most important objective to be accomplished in the biggest cities and consequently in the largest systems for vehicles traffic control and aiding:
   - vehicles traffic controlling by means of traffic lights,
   - public transport vehicles controlling,
   - municipal services communication,
   - controlling for the vehicles trying to find the parking areas,
   - vehicles traffic controlling and supervision for direct highways,
   - vehicles traffic controlling within the sections between interchanges and in tunnels,
   - vehicles traffic controlling to detour and substitution routes (alternatively).
2. Owing to common application of digital processing of measuring signals occurring in detectors, a higher level of road traffic control system unification is possible.
3. The analysis of TETRA trunking communication system indicated its significant advantages in the scope of communication with municipal services in comparison with conventional systems. Its additional advantages are: increased resistance to disturbances and digital voice transmission. The application of digital technology enables the creation of multifunctional applications facilitating the vehicles management and the integration of vehicles positioning systems with traffic lights management system in future.

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