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TELEMETRIC METHODS FOR MONITORING OF THE ROAD SURFACE CONDITIONS

The increasing cost of road maintenance, especially winter maintenance of road surface and infrastructure to keep it fit for safe and undisturbed traffic, makes the road administration develop systems providing actual information about weather conditions and road surface state, thus enabling to start the maintenance procedures early enough.

TELEMETRYCZNE METODY MONITORINGU WARUNKÓW POWIERZCHNI DROGI

Wzrastające koszty utrzymania dróg, a szczególnie zimowego utrzymania nawierzchni dróg i infrastruktury pod względem bezpiecznego i niezakłóconego ruchu prowadzi do stworzenia przez administrację drogową systemów przetwarzających aktualne informacje o warunkach pogodowych i stanie nawierzchni drogowych, co pozwala na wystarczająco wczesne uruchomienie procedur utrzymaniowych.

1. INTRODUCTION

The road as a section of terrain designated for traffic of vehicles and people becomes more and more complicated technical structure. To be able to perform its functions, it has to be equipped with miscellaneous technical devices enabling safe and fluent traffic. The road traffic support requires current information about the road and traffic state.

Road remote sensing and road telemetry are areas of measurement techniques dealing with remote transfer of measurement results and control signals and acquiring information about roads and traffic. The development of road telematics in Poland started with the creation on demand of

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road administration, of the first road glazed frost warning stations measuring the current weather conditions on the roads and transferring the data to road service offices.

As the weather conditions measurement system was developed it occurred that it can be expanded and used in many ways meeting the needs of the following main users:

- Road administration

It uses the weather data from road glazed frost warning stations for assessment of the danger. The current meteorological information aids the decision processes concerning maintenance, especially for glazed frost prevention and removal.

- Road users

The data from road stations are used for informing about glazed frost by means of notice-board systems.

- Other public services responsible for road traffic (police, local administration etc.)

The information about risks in road traffic enables to early put to alert state the appropriate services and preparing them for intervention.

Smart road glazed frost warning stations with autonomous power supply and searching for telecommunication link are the basis for road telemetry system.

The next steps in road telematics development are the following:

- Camera system for road observations

  It enables to observe the road traffic and assess the road surface state, as well as to support meteorological stations with precipitation state observations and the snow cover measurement. The camera system may be equipped with remotely controlled rotating heads and flexible focus objectives, which enables to observe a great section of the road. Modern camera systems have software for vehicles counting.

- Notice-boards

  They are designated for road users and inform about current temperatures (e.g. surface and air), strong wind, and in case of glazed frost risk inform by means of warning inscription or traffic sign. There is possibility to control traffic signs (e.g. speed limits in case of glazed frost) directly by the road warning stations or remotely from the road service offices. The experience of other countries shows that the notice boards may also inform about other traffic risks, e.g. impassability of road sections.

- Visibility measurement instruments

  They are usually placed by the measurement stations located in the areas of frequent fogs. They can transfer the information about fog to road service offices or control the notice boards and the speed limitation traffic signs and laser road edge indicators.

- Traffic intensity measurement instruments

  They provide the road services with information about the current intensity of road traffic and with data about long-term distribution of traffic on indicated routes. The traffic measurement system may be equipped with instruments for measurement of speed and kind of vehicles.

The transformed data from road measurement stations are the basis for decisions concerning the time and kind of maintenance actions and traffic signs control, so the quality of the data has crucial influence on the quality of the decisions and transferred information. It became necessary to create a mobile control instrument in the form of measurement station.

In the first phase it was equipped with a set of instruments controlled by a computer enabling to control the meteorological parameters of the road glazed frost warning station. Next, similarly to the road station, its measuring capabilities were extended.

The mobile measurement station was equipped with a scanner for remote measurement of road section surface temperature (thermal profiles), aiding the assessment of glazed frost risks on road sections.

Then the mobile station was equipped with digitally controlled camera system. It enables to catalogue the state of road surfaces, bridges, viaducts and road instruments such as: vertical and horizontal signs, road lighting etc. It is also considered to equip the mobile station with an instrument for luminance measurement enabling to assess the visibility of traffic signs at various conditions of natural and artificial lighting. Appropriate software enables to automatically discover any changes in the road infrastructure in comparison with the previously recorded state.

The road instrument cataloguing requires precise defining of the object location. It is achieved by means of establishing the road number and distance as well as by installing GPS on the vehicle to precisely locate the instrument site on the terrain map.

In extreme conditions the mobile station uses thermovision camera of DGPS defined position with extended color palette showing the road surface temperature mosaic. The possibility to assess the temperature change against the thermal profile and road record pattern.

2. ROAD NETWORK

Hitherto existing state road network comprised 46 000 km. After the reform the network was reduced to about16 000 km main roads.
The state roads controlled centrally are the following:

* highways and express roads,
* international roads,
* alternative roads for paid highways,
* access roads for border crossings for international traffic,
* peripheral roads in great cities,
* strategic roads.

The new state road network is shown on the map.

The new network was established according to the following criteria:

a) roads in main transportation corridors, the future highways A-1, A-2, A-3 and A-4 and additional connections - express roads (Via Baltica) Gdańsk - Warszawa - Lwów - Kijów, Warszawa - Wrocław - Praha and other interregional roads (express roads), alternative roads for highways, roads to border crossings,
b) traffic intensity criterion, currently over 4 000 vehicles per day.

Part of state roads became **provincial roads** (about 30 000 km) included into the category by provincial councils.

Hitherto existing provincial roads became **district roads** (about 130 000 km) included into the category by district councils.

According to the change of the act concerning public roads, the General Management of Public Roads acts as a centralized organization composed of 9 regional departments (Fig.1):

* central department, HQ in Warszawa,
* north-west department, HQ in Szczecin,
* north department, HQ in Gdańsk,
* north-east department, HQ in Białystok,
* west department, HQ in Poznań,
* east department, HQ in Lublin,
* south-west department, HQ in Wrocław,
* south department, HQ in Katowice,
* south-east department, HQ in Kraków.

Fig.1. Regional departments of GDDP map

Road regions (about 150-200) are subordinates to the regional departments. The crews are prepared for investment and patrolling tasks on the roads and for direct administrative service for road users.

GDDP controls only main state roads of international and interregional imprtance. Provincial councils control the provincial roads, and district councils control the district oads. In 67 towns of the district status town council controls all the roads. The structure of the roadnetwork and responsibility appointment after the reform is shown in table 1.

Table1

The structure of the road network and responsibility appointment

	Roads	Length ths. km	Control	Financing
1	All roads in towns of district status	28	Town council	District budget
2	State	16	GDDP	State budget
3	Provincial	29	Provincial council	Provincial budget
4	District	130	District council	District budget
5	Communal	171	Communal council	Communal budget
	TOTAL	**374**		

The tasking for state road administration requires in particular:

* adjusting the road network to the European Union standards, hence intensive investing and modernizing,
* flexibility of control within the state enabling e.g. to shift traffic between main transportation corridors and routes,
* continuous and round the clock road patrolling and quick reaction and prevention

Each of the regional departments must be equipped with telematics road control center. Coexistence of roads controlled by various structures (state, provincial, municipal etc.) requires reference to geographic information systems (GIS) and terrain information systems.

To create the possibility of real time usage of satellite spectroradiometric data and weather charts in connection with the measurements conducted by meteorological road stations and thermal maps combined with radioscanners measurements (profiles, records), finally to refer to real terrain model (SIT, GIS) it is necessary to develop functional model of information system SI/GIS in connection with other systems.

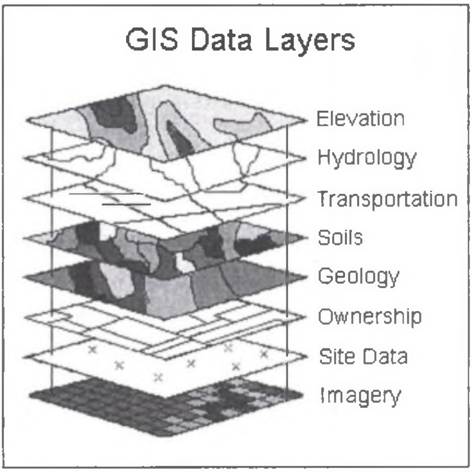

Fig.2. GIS data layers

3. THE STRUCTURE OF CONTROLLING SI/GIS SYSTEM

The experience from developing and implementing information systems prove that the main time and resources consuming task is the creation, verification and maintaining of databases. It makes the usage of the existing systems necessary. When selecting such an existing system to be used it is necessary to take the following into consideration:

- data exchange interface with automated systems (ACS - Automated Cartographic System, GIS - Geographic Information System and data processing systems (DPS));
- data exchange interface with database control system (DBCS);
- data search in the database by means of *numerical map*;
- object location search on numerical map;
- object dependent map scaling;
- cartometric measurements on numerical map with the precision of the geographical one for the scale of the traditional map;
- typical documents acquiring in the form of tables, descriptions and drawings.

The system's functional model and its connections with other systems is shown in Fig.3.

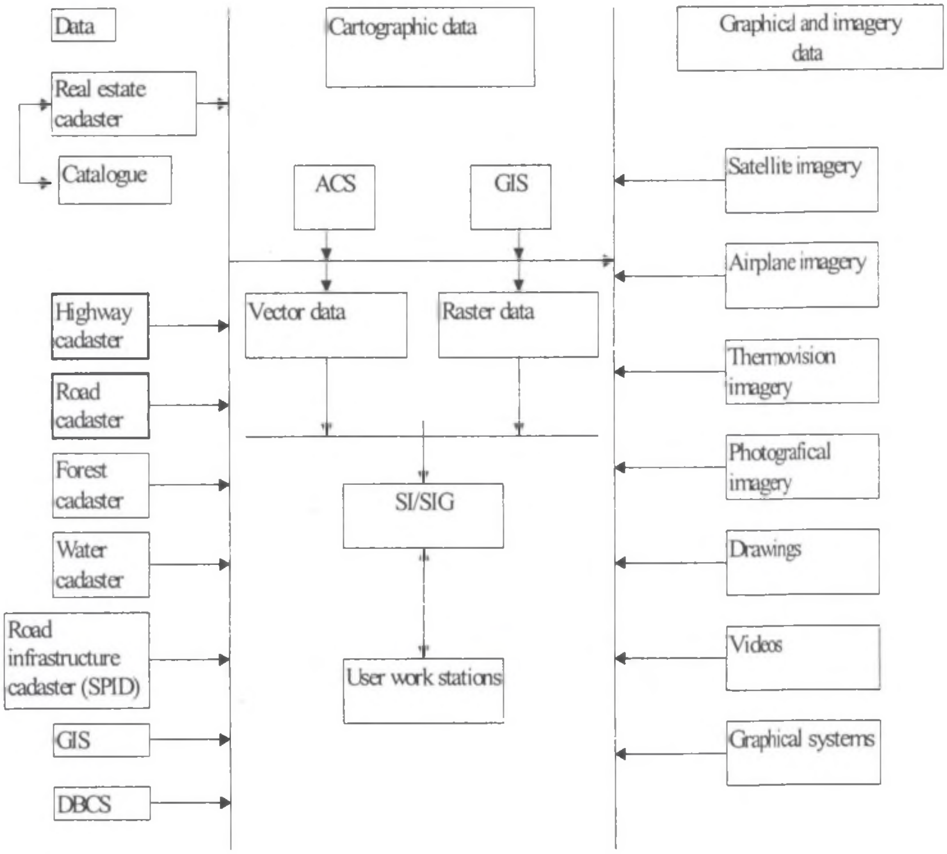

Fig.3. SI/SIG connections to other information systems

4. SI/SIG INFORMATION BASE

The SI/SIG control software should include the following subsystems to be able to realize the system's functions (Fig.4):

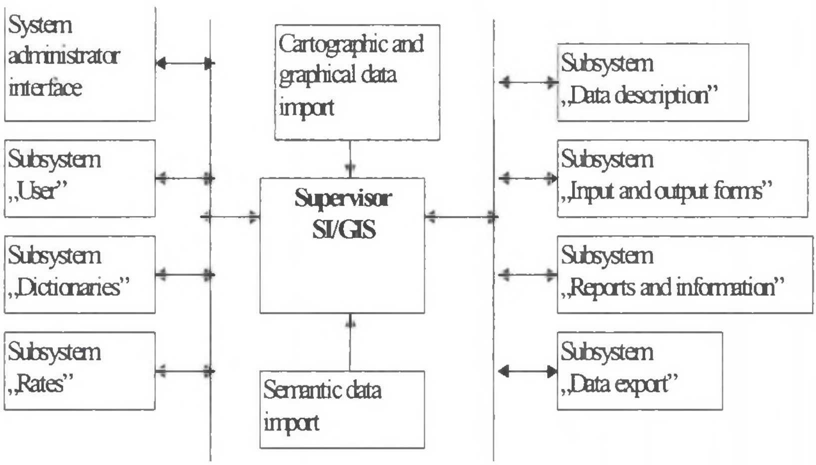

Fig.4. SI/GIS information base scheme

The subsystem „Data import" provides data conversion from formats of databases (Oracle, Informix, dBase, SQL) to object oriented data models on system's logical level. In local variant work the cadaster data are imported to the user workstation. In network variant only the necessary data are realized for defined task solving (inquiry) according to the requirements of ERTICO ITS-Europe.

5. CONCLUSION

Polish Road Weather System connection to SIT/GIS systems and other information systems of state administration and intervention services by means of telematics centers of central department and regional departments will provide coherent and reliable work of road maintenance services in Poland.

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