Smart and reliable roadside monitoring system with UMB technology

Karl E. Schedler
Dipl.Ing.Univ.
KS-Consulting, micKS MSR GmbH,
Oberstdorf, Germany
info@ks-consulting.de, schedler@micks.de

SUMMARY

Reliable, easy to operate and cost effective monitoring stations on the roadside are the most important data source for road and weather condition information. In hazardous Weather situations this data sources enable information systems to gain reliable information and warnings for maintenance operators and car drivers.
A new modular fieldbus based technology was developed by LUFFT GmbH Fellbach. The UMB Technology offers all necessary sensor types for road and weather conditions as well as intelligent road pavement sensors and microwave radar based precipitation detection and present weather recognition. The technology was designed for low power consumption to enable solar or fuel cell power supply.

1. INTRODUCTION

Road Weather information systems became more and more indispensable and important for supporting winter maintenance decisions. Winter maintenance decision support makes the highest demands on quality and range of measurements, information and forecasts. This highly sophisticated data should also be used for traveller and traffic information. Road weather information systems are part of the road infrastructure and the telematic field.

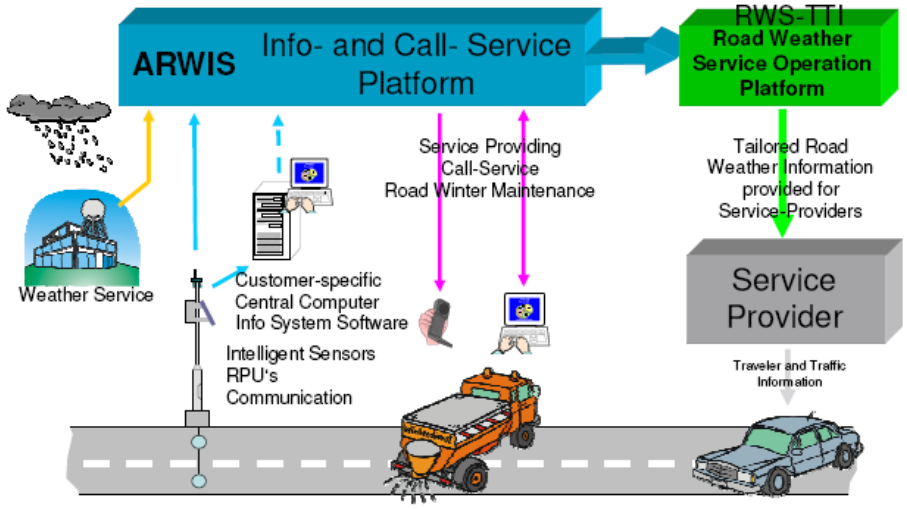

figure 1 Road Weather information Policy

The field of Road Weather Information comprises the following issues: Weather Services dealing with global atmospheric weather data and forecasts, the road weather remote stations acquiring all weather related road condition data, the road weather information central computers or comprehensive information and decision support services for the road maintenance organisations and also road weather content- and service- operation platforms for traveller and traffic information purposes.

2. INTELLIGENT SENSOR DEVICES

Reliable and precise data directly from the road pavement are an essential requirement for maintenance decision support. In order to make it affordable to densify the acquisition network on the road, easy to install, compact, intelligent and maintenance friendly devices are necessary. The German company LUFFT GmbH has developed intelligent devices both for road pavement condition detection and for atmospheric road side weather situation. A complete road weather remote station can therefore be composed of two sensor devices only – the minimum amount possible.

2.1 Combined sensor device for atmospheric weather

The atmospheric weather detector device WS600 comprises "all in one" the following measures:

- Type and Intensity of Precipitation with an innovative Doppler radar sensor (R2S see [2])
- Direction and Speed of wind, with a non-mechanical ultrasonic transducer (WS600)
- Air pressure with a an built in pressure transducer
- Air temperature and relative humidity within a protection shield, with an active ventilation in order to rise the response time and ensure accurate measurement of the surrounding atmosphere

figure 2 WS400 and WS600 "All in One" atmospheric sensor device (LUFFT GmbH)

The device has one serial interface where all measured data are reported. The communication protocol specification is open and can be easily implemented also in OEM solutions. A lot of applications are already realized by several OEM Partner. For example within Intelligent Vehicle Highway Systems for measurement of precipitation and aquaplaning situations it is used in environmental remote station.

2.1.1 Innovative microwave Doppler radar principle for precipitation measurement

Since about 4 Years when LUFFT introduces at first the R2S radar precipitation detector, the principle has proven its reliability in several evaluation tests in different institutions and has been approved in numerous installations on the field. The principle is predestined for operation in the environment of road traffic. Compared to optic sensor the disadvantages of getting dirty or being influenced by insects or light reflection effects are no longer a problem. The only precondition is heating during freezing temperatures in order to prevent forming of ice on the surface of the transducer cupola. The sensor is absolutely maintenance free. The Doppler Radar with a certain small microwave frequency at approx. 24GHz measures the speed and dimension of the falling precipitation particles and recognizes their type and calculates the equivalent intensity in mm/h. The resolution of the measurement is 0,01 mm and the reproducibility is more than 90%.

2.2. Combined sensor device for road pavement condition

In hundreds of installations the IRS series of road surface sensors from LUFFT was very successful in reporting accurate all important parameters appropriate to evaluate the condition of the road surface in order to support the decision of the maintenance people and for information of the car drivers.
One of the mechanical advantage is the possibility of easily removing the electronic transducer inlet in order to exchange it into a calibrated new device. Repair or recalibration can be done in a laboratory environment. Therefore the live time cost of an installation can be significantly reduced.
The road surface detector IRSxx ([3]) comprises "all in one" the following measures:

- Road surface Temperature
- Up to 2 Subsurface Temperature probes (e.g. for a depth of 30 cm)
- Waterfilm depth measurement by means of a microwave radar transducer
- Freeze Point Temperature from the chemical concentration of the solution by their conductivity measured with gold electrodes and under consideration of the waterfilm thickness and the temperature
- Road surface condition (dry, ice, wet, slush) measured by the dielectric characteristics of the cover.

figure 3 Intelligent Road Surface Sensor IRS31 with housing and the inlet module itself

The complete device has low power consumption. The electronic in the inlet module provides the ready to use measures in the units necessary for the application. A serial interface with an open protocol specification makes it easy to implement into different OEM solutions.

2.2.1. Microwave radar transducer for water film depth

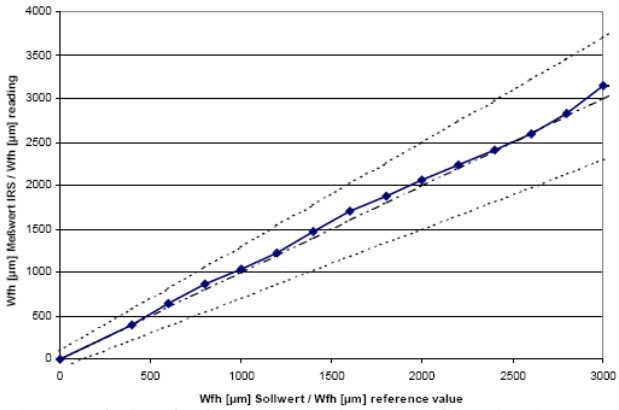

figure 4 characteristic of microwave radar water film depth measurement

Accurate measurement of water film height is achieved by a microwave radar transducer built in the IRS series pavement sensor device. figure 4 shows the characteristic and calibration curve of the radar transducer. The water film height is reported with a resolution of 0.01 mm.

2.3 Proof of the Quality and calibration certification

To ensure the quality of data acquisition every sensor is tested and calibrated before delivery. This should become a standard. Every sensor at LUFFT will be delivered together with a calibration certificate which shows the calibration characteristic of the sensor.

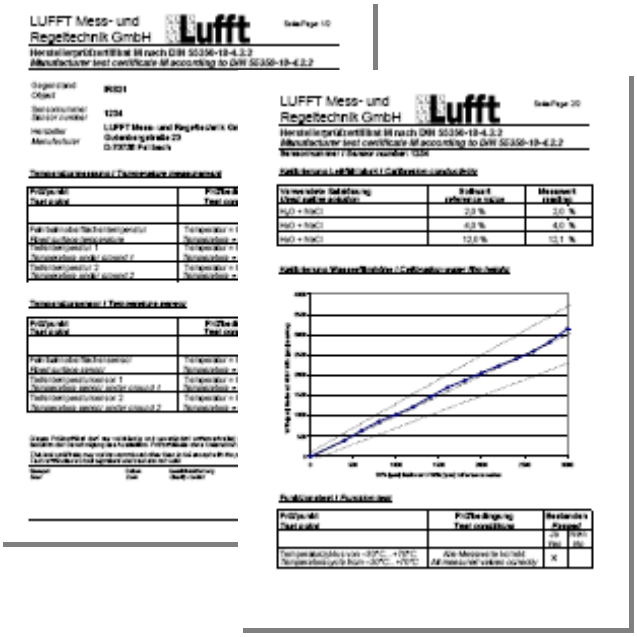

figure 5 calibration certificate with waterfilm depth characteristic

2.4 Modular remote stations with UMB Technology

Road Weather and environmental remote stations should be well arranged and arbitrarily extendable. The UMB Technology provides – among others - these sophisticated features. The Technology also is designed for low power consumption – which allows – under certain conditions - solar or/and fuel cell power supply assembly.
Each top hat rail plugged UMB Module can control one Sensor or a complex sensor device. A mobile Phone network communication can be established by adding a GPRS Module. National or international line communication protocols, such as TLS or NTCIP can be supported by adding a LCOM Module (a small top hat rail mounted IPC). More about UMB Technology can be obtained from [1].

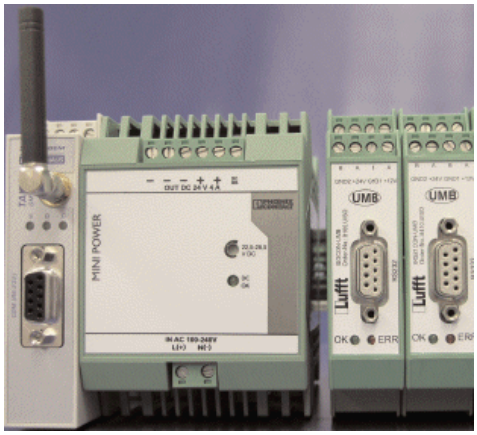

figure 6 Two UMB Technology modules, with Power Supply and Modem sufficient for a complete remote station with atmospheric and road surface sensors

The German company LUFFT has developed intelligent devices both for road pavement condition detection and for atmospheric road side weather situation. A complete road weather remote station can now be composed of two sensor devices only – the minimum amount possible.

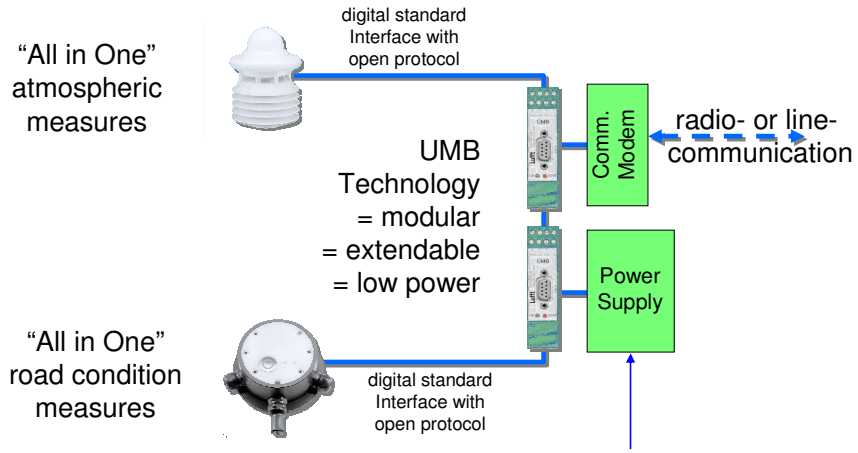

figure 7 a complete road weather station built up with a few elements

3. STAND ALONE CENTRAL COMPUTER SOLUTIONS: SMARTVIEW

On a central computer the SmartCom collector software controls the data acquisition from remote stations. Supporting different communication media makes it easy to choose the optimal and cost effective way for the application. The data were directly stored in a SQL standard database.

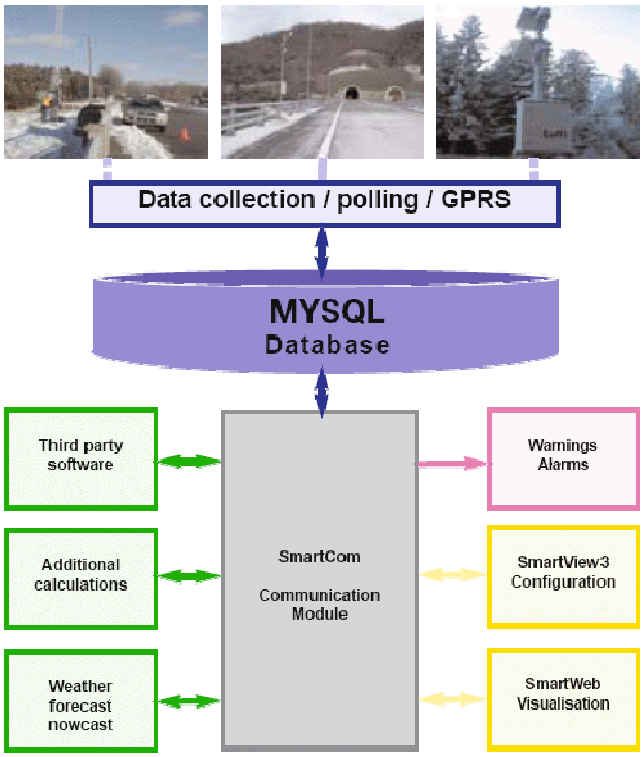

figure 8 Structure of the SmartView RWIS central computer software

Around the database application specific modules can be installed. For winter maintenance users it is important to view the information with standard tools from different places within a computer network. SMARTVIEW

therefore has a WEB Interface. The display adapts itself to the setup of the remote station. More about the software modules can be found in [4].

3.1 Camera pictures help maintenance people in assessing the road condition

Visual inspection of the road condition is the most informative way. Together with accurate measured data experienced people can gain a full knowledge about the actual situation on site. Still pictures can be taken in certain intervals (1 … 15 minutes) and together with the measured data transferred to the central computer or to the service platform.

figure 9 Example picture and indicator display of data from a road site in Bavaria

4. REFERENCES

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