Autonomous Road Weather System– A Cost-effective Way to Increase Monitoring Points on a Road Network

Accurate weather information plays an important role in road trafficmanagement allowing operators to warn drivers of poor conditions, and take precautionary actions such as reducing speed limits or gritting roads. For road weather a combination of forecast information and empirical data collected from roadside outstations is used to anticipate potential problems which might affect road safety or traffic flow. Forecasts have improved over the years but they are still not 100% reliable and so verification of actual conditions through site measurement is vital.

Where to Measure?

In the UK a local authority typically has responsibility for roads within an area of up to 5,000 km^2 often containing a wide variation of terrain and elevations. Clearly several different weather conditions might be occurring simultaneously within that region.

The more monitoring points each area has the more detailed the picture of current weather conditions that can be formed. However, traditional roadside weather stations are costly to purchase and maintain, require road closure during installation and rely on mains power and fixed line communications.

This means that such stations are deployed sparingly, providing measurements from just a handful of locations. They are usually sited at known problem sites or sites deemed to be representative. With only a few measurement points to cover a large and diverse territory, localised decisions are not usually possible. This can mean blanket precautionary road salting on roads which do not need it or salt not being applied when in fact, on some roads, it is needed. So what is the solution?

Non-Intrusive Infra-Red Temperature Monitoring

Infra-red temperature sensors are relatively inexpensive and, offer a non-invasive method of reporting the temperature of a remote surface, and so can be used as a cost-effective way to measure road temperatures. Of course, they still need power and a way to transmit the data back.

Campbell Scientific have therefore integrated such a sensor into an intelligent roadside monitoring system which requires neither mains power nor fixed line communications and which can be deployed quickly with minimal disruption to road users.

The system consists of an IR100 remote temperature sensor with a special housing and an environmental enclosure containing a Campbell Scientific CR850 data logger, a GPRS data modem, an air temperature and relative humidity probe and a power pack charged by an integral solar panel.

Campbell Scientific's Infra-Red Road Weather Station with integral power and communications provides a cost effective way to monitor more sites

The enclosure has industry standard channel clamp fittings for a metal banding installation on any suitable roadside post or overhead gantry (existing posts are typically utilised for cost saving and speed/ease of the installation process). The sensor is mounted away from the main enclosure, with the height and angle determined according to the instep distance of the post from the roadside and the viewing ellipse required. The sensor measures a spatial average temperature across its field of view (half angle 11°) rather than taking a spot value. For example, mounted at 5m and at an angle of 45° the measurement ellipse is 4.0m with an instep value of 3.4m; increasing the height or angle gives a larger measurement ellipse, perhaps to cover more than one carriageway.

The integral data logger is pre-programmed to take measurements every five seconds and store processed values every 10 minutes, these values are then communicated every 20 minutes when the logger dials out through the GPRS modem. This gives a 10 minute resolution and maximum real time lag of 20 minutes.

The system reports road surface temperature, air temperature, relative humidity, dew point, panel temperature and battery status.

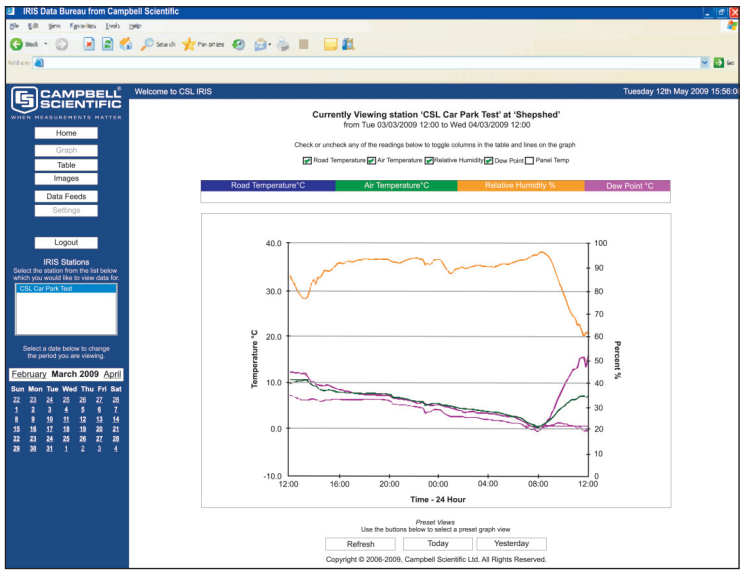
The program contains a unique algorithm which automatically compensates for site variables such as surface emissivity* and sky view** which are entered on the integral keyboard display unit. Traffic is automatically filtered from the results to give accurate reports even with moderate to heavy traffic conditions.

* Emissivity values are provided for asphalt, concrete, brick, ice, snow and ocean.

** Sky view factor, as the name implies, is a measure of the degree to which the sky for a given point is obscured by the surroundings – as this can be difficult to determine by eye this is factory set to a typical value.

Who Owns The Data?

Like traditional road weather stations, data on this system is collected, processed and saved by a data logger ready for scheduled transmission via the installed modem. However, this system differs from such stations in that here the data logger actively dials out onto the GPRS network rather than using fixed line communications*. The logger can be programmed to connect to the GPRS network and establish a callback to a given public IP address, which leads to the second big difference in data communication of this system.



A screenshot of the standard user interface showing the graphing facilty for viewing the latest measurements

Traditionally manufacturers of road weather hardware also provide a bureau service to collect, archive and serve the data to the end user at a contracted cost, with further fees charged for data provision to a third party such as the forecast service provider or a neighbouring authority. Bureau costs often represent a significant proportion of the cost of running such systems. Campbell Scientific, however, believe that ownership of the measured data resides with the equipment owner and so, on this system, there are two options for data collection:

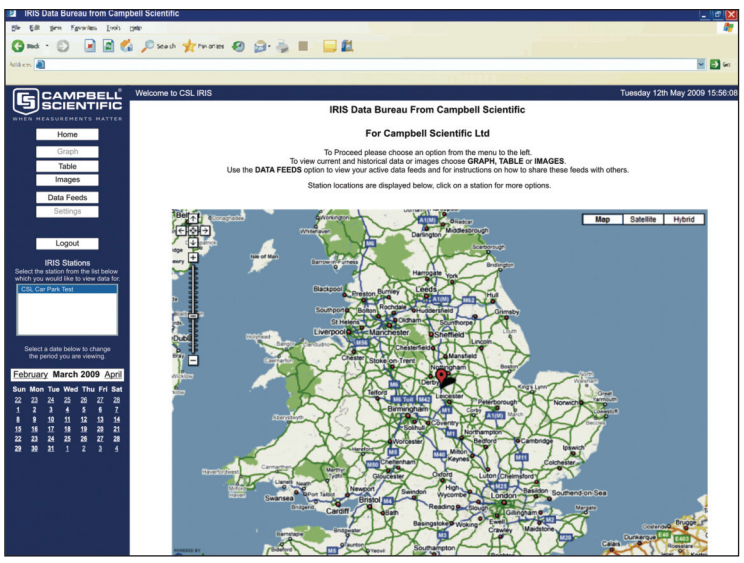
1. Data can be collected directly by the customer via the GPRS modem using suitable software at no charge. In this instance the customer would own the SIM card and pay for the data transmission calls to the GPRS service provider.
2. Campbell Scientific can collect data on behalf of a client for a nominal fee and serve it over the internet allowing password controlled access from any computer with an internet connection. An easy-to-use interface is provided. In this instance Campbell Scientific own the SIM and the fee covers the call costs. Unlimited additional access for third parties via a data feed is not charged for.

This data bureau service gives operators secure internet access via an intuitive user interface. It provides a graphical display of the current latest data and tabular access to historical data. Customers may also

elect to share their data with an unlimited number of interested third parties without additional cost. This is achieved by setting up a data feed via the user interface and providing the third party with the data feed location.

Customised user interfaces are an option (at extra cost) and we have worked with clients to create bespoke data displays adding visual and audible alarms, map overlays and other features.

*Must be installed within range of GPRS network coverage



A screenshot showing the bureau home page where if multiple stations are owned they can be selected by location directly from the map

Take the Weather With You

Whilst these units are not intended to be portable as such, their integrated power and communication systems and simple channel clamp installation does mean that they can be uninstalled and re-deployed at a new location quickly and easily. They can therefore be used for short term monitoring applications perhaps to cover a temporary diversion route or for a specific event.

System Expansion

The standard system reports on surface temperature, air temperature, relative humidity and dew point however the integral logger has the capacity to handle other inputs too. Therefore this system could potentially be extended by the addition of other sensors if required (wind, precipitation etc. for example) as long as the total power consumption does not exceed that which can be handled by the battery/solar panel power source. Additional sensors would require a custom interface.

Summary

This system offers a cost-effective way to gather road weather conditions from a large number of monitoring points. Power and communications are integrated making installation simple and quick.

Although these devices are fully independent they are designed to be networked and to augment the data provided by existing full blown roadside outstations. The ultimate point to this system is to help make roads safer during inclement weather whilst simultaneously allowing efficiencies to be made in road salting operations through localised gritting decisions.

Finally, it should be borne in mind that although this system was designed with roads in mind the road could, in fact, be a runway or a railway or indeed any surface.

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