BEMS Bridge Environmental Monitoring System

Environmental Data Systems Inc.

BEMS DATA ACQUISITION SYSTEM DESCRIPTION

The BEMS data acquisition system consists of a central computer (CPU) and sensors located at various places along the bridge. The computer is a small low power Linux based system which supports most of the popular I/O ports (Ethernet, USB , RS232/RS485, PCI) and has virtually unlimited data storage capability through the use of USB memory drives. This computer can be continuously connected to the Internet via a cellular air card or DSL / Cable modem and router or can connect to the internet on a timed interval using dial-up cellular or land line modems. Direct connection of the users computer is also possible over the internet, by dial up connection, or on-site via the LAN port. The Linux operating system is hack proof and supports HTTP (web) , FTP and SSH servers. The system can be entirely remote controlled via the internet. The CPU and sensors are low power (12VDC) and can be powered by solar, wind or AC line power.

CP System
Bridge of Lions

The BEMS system uses modular DIN rail mounted components and can be installed virtually anywhere in a variety of standard NEMA enclosures. The modular construction of the BEMS system allows custom data acquisition and control solutions to be easily created for each bridge monitoring application. Components of the system can be widely distributed along the bridge to best suit the particular environment and monitoring needs. Maintenance and repair of the system is made easy by simply unplugging and replacing the defective module, drastically reducing cost and downtime when compared to other systems. Expanding the system to incorporate additional or new sensors does not require modification of the existing installation. The new sensors are installed on the bridge and then connected to the existing system via a 4 wire cable or data radio.

The sensors are connected to the CPU via an RS485 network. The RS485 network is used by most types of sensors either directly or through the use of commercially available low cost interface modules. The RS485 network can send data for thousands of feet on a single pair of wires. The network can be extended to any point on the bridge through the use of data radios. The system can support virtually any type of sensor available from most manufacturers. The system can also be used to control remote devices via the use of digital input / output modules.

Sunrise at Gandy Bridge

The BEMS system can read and store data from a wide variety of sensors. The sensors can be mounted anywhere on , under or near the bridge. One CPU can be connected to many different types of sensors at the same time. A single CPU can be used to measure and control CP systems, read weather data, tide information, temperatures and many other parameters of interest in bridge maintenance / monitoring. The CPU also incorporates 4 video inputs capable of recording still pictures or streaming video. A wide variety of cameras and microscopes are compatible with the BEMS system.

View from top of Tower
Skyway Bridge

Each sensor on the RS485 network has a unique address. The CPU sends a "Transmit Data" command to each sensor on a preset time interval. The CPU receives the data from the sensor, processes this raw data into engineering units, then stores the data in its internal memory. The collected data files are then compressed to approximately 1/10 of the original size and transmitted to the FDOT web site using FTP protocol. This happens automatically every half hour.

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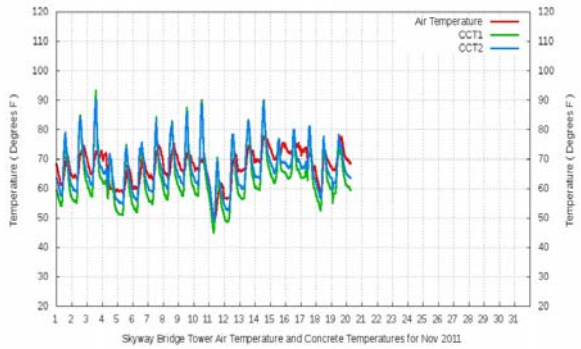
FDOT computers at the SMO office retrieve these data files from the web site, decompress them and generate the web pages and graphics seen on the web site. The web pages and graphics are then uploaded to the web site for public use and also archived in the FDOT computer system. This occurs automatically at a preset time interval. The BEMS CPU can also generate web pages and graphs (the FDOT office computer runs the same software as the logger) but this task is usually left to office computers due to the large bandwidth requirement. Logger generated graphs and web pages may be practical in stand alone systems or systems with high speed network connections such as DSL, Cable or internal LAN.



The entire recording, transmission , processing and backup of the data occurs automatically. Recorded data files stored on the internet are directly compatible with Excel and other spreadsheet and data processing software.

Adding sensors to the systems is straightforward. Sensors can be placed virtually anywhere on the bridge as follows:

Sensor interface and radio
Dames Point Bridge

1. Provide power source. The power source can be AC power from bridge wiring, solar panels, wind generators or disposable batteries.

2. Provide data communications with CPU. Most sensors can use the RS485 radios. The radios can be placed hundreds of feet from the sensors if necessary and connected via a single 4 conductor cable.

3. Install the sensor at the point where the parameter is to be measured.

Install interface device if necessary. Low cost interface modules are available which support most types of sensor outputs such as thermocouple, voltage, 4 – 20 mA, strain gauge (resistor bridge), frequency etc.

Tide Sensor
Dames Point Bridge

For example most accelerometer sensors have a voltage output. The sensor would be installed and wired to an A/D converter mounted in a small watertight enclosure nearby.

A small solar panel and battery is also mounted nearby to power the unit. Finally the radio is mounted to have a clear view of the CPU radio. That's all there is to it. The CPU can then find the sensor via the radio and download , store and transmit the data output as described above. It should be noted that other types of sensors can be connected to this installation at the same time. For example, temperature sensors can be added to the A/D inputs, or other interface modules can be connected to the power source and radio. Any number of remote stations can be accommodated.

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This system is installed on many bridges in the State of Florida and supports a wide variety of sensors. The following is a partial list of sensors that are currently installed on bridges or have been tested with the system.

General Purpose:
- AC or DC Voltages
- AC or DC Current
- Frequency
- Resistance
- Temperature
- Event monitoring (Opening / Closing of gates, doors, hydraulic actuator position etc)

Weather:
- Wind Speed
- Wind Direction
- Air Temperature
- Barometric Pressure
- Humidity
- Rainfall
- Dew Point
- Wetness
- Ultraviolet Light
- Sunlight

Mechanical:
- Distance (ultrasonic)
- Distance (infrared)
- Distance (Laser)
- Distance (LVDT)
- Acceleration / Tilt
- Weight / Force
- Pressure (0 to > 1000 PSI)
- Strain Gauge
- Rotation (RPM)

Remote Control:
- Turn ON / OFF AC power to pumps, lights, motors any current / voltage rating.
- Operate hydraulic / pneumatic Actuators.
- Custom control software for Automatic operation of Control systems.

Water:
- Water Current
- Water Temperature
- Water Depth
- Scour
- Conductivity
- pH
- Dissolved Oxygen
- Turbidity

Video:
- Still Color pictures
- Hi-res Color pictures
- Streaming Video
- Microscope (Small self contained field installable w/ light up to 400X)
- Underwater (Up to 300 feet)

*Pictures can be triggered based on output of other sensors i.e. distance change

Cathodic Protection:
- Rectifier Output Voltage
- Rectifier Output Current
- Ag/Cl Reference Cells
- Concrete Temperature
- ZRA (Zero Resistance Ammeter)
- Current Density Probes
- Concrete Conductivity
- Concrete Chloride level