Title

PERSONAL ENVIRONMENTAL MONITORING SYSTEM USING MOBILE SENSORS WITH MODULAR ARCHITECTURE TECHNOLOGY

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Abstract

Environmental monitoring is a key concern in underground mines, such as part of the Andina Division copper mine of Codelco, in central Chile. The concentration of dust is important due to its negative effect in workers health. Regrettably, sensors for this parameter are costly and therefore implementing a full scale monitoring network of fixed devices could be prohibitive. Another alternative is to use a mobile sensor/recorder. The problem is that analysis of the data can take place far apart in time with respect to the original measurement, preventing timely response. This paper describes work done jointly by Codelco and the Center for Mathematical Modeling from the University of Chile, in order to create a prototype Mobile Monitoring Station (MMS)..

CMM proposed the use of a recently unveiled technology: the BUGs, by a NY technology startup, Bug Labs lnc.. These are handheld-sized prototyping platforms, with both open hardware and software. The architecture is comprised by a base that supports supports Linux and modules such as a touch screen and digital I/O. It hosts and embedded web-server, so one can put together a device and deliver web-services in very short time, and just as easily take it apart and add different modules to produce a different outcome.

The architecture design proposed considered the BUG as a personal aggregator, recorder and interface to sensors data. Access Points would also be used in locations were automatic download of the data from the BUG would occur. These are connected to a TCP/IP network and convey data to a central web-server. Regarding communication from sensors to the BUG and from these to the Access Points, WiFi, Bluetooth and IEEE 802. l 5.4 were tested. The latter proved to be a good combination of battery life, throughput, ease of integration and device cost. XBee radios were added to the sensors and the BUG. IEEE 80215.4 to TCP/IP gateways were used as Access Points. The BUG is the coordinator of a star topology: sensors and the BUG form a mobile self-contained network, and when it enters the range of an Access Point, this device also joins the network.

A usability study suggested that the best way to physically carry the MMS would be as a jacket; this way, the operator can carry the system and measure his surroundings without repercussion to his/her regular duty. An LED alert was placed in the sleeve, which is used to inform the user of dangerous readings, and at the same time a warning is sent to the central web-server.

Field trials have demonstrated the correct functioning of system subparts, including user interface, sensor to BUG and BUG to Access Point connectivity, and web-server. However, a complete system trial is yet pending. Main conclusions are as follows:

- The usage of a personal unit to hold measurements while in areas without wireless coverage has proven useful since the user has a unified interface to all the information. However, since miners currently wear many pieces of equipment, it is undesirable to add more. One way around this is to create a device that could merge the sensor recording/interface functionality along with the communication and network access that digital two-way radios currently offer.
- Commercially available sensors have proven unfriendly towards integration with other systems, which reveals an absence in the market for easy-to-integrate sensors for developers of new solutions.
- Work done so far suggests that automatic download of personal measurement data, along with wearable systems could prove very useful in mining/heavy industry. On the other hand, practical applications will require custom design of garments for different tasks, better autonomy and reduced hardware cost.