SENSOR WEB FOR REMOTE AND UNATTENDED ENVIRONMENT MONITORING

Final Report

JPL Task 983

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A. OBJECTIVES

We planned on demonstrating a Sensor Web [1,2] that can be deployed in a remote and unattended environment, and showing that the information gathered and processed by the web can be transferred to scientists in their offices in real-time. The web will track the spatio-temporal changes in local environments. The systems were tested in environmental laboratory chambers and are presently deployed in-field.

B. PROGRESS AND RESULTS

1. A graphical user interface (GUI) was perfected, suitable for Internet viewing. The GUI is interactive and allows the user to display different pods, different measurements to study, and to look at both archived and real-time data. The GUI is meant to be globally accessible over slow (56K modem) connections, and platform independent (PC, Mac, Netscape, IE).

2. A package was designed to withstand a variety of environments, ranging from temperatures of 70°C to –40°C. The following design changes were incorporated into the package:

   - Improved gasket: Instead of a polyurethane (shore 30-40A) material in the form of an O-ring, a 1/16" silicon sponge with a pressure sensitive adhesive backing was chosen. The location of the gasket moved to outside the groove, which increased the sealing area, minimized unnecessary gasket compression, thus increasing life expectancy, and decreased assembly difficulties. The pressure-sensitive backing also reduced the risk of potential twisting during assembly and in field deployment. The material selection better handles the temperature requirements.
   - Antenna seals: Ethylene Propylene O-rings fitted into counterbores replaced the vibration isolators as the sealing method for the antennas. The material selection handles impermeability, temperature cycling, compression set, and weathering far better than the polyurethane isolator. The design offers easier and faster installment.

- Board deflection was addressed through a change in the antenna/board connection design. Instead of a press contact, which caused the bending, a fixed design was chosen which used a nut and bolt on the antenna stud. This not only improved the connection, it also added robustness and eliminated any loading on the electronics board.
- Thread-forming fasteners replaced the insert/machine screw attachment device in the six middle locations. The thermal cycling seen in the test experiences started to develop cracks in the pod shell due to thermal expansion differences between the polycarbonate box and the brass inserts. The softer, silicon sponge gasket decreased preload on the screws needed for gasket compression, thus allowing the thread-forming fasteners to be used with no operational sacrifices. Inserts were left in the corners due to the large number of assembly and disassembly operations. Additional material at these locations minimized the possibility of a crack-causing leak. Cost per pod also decreased with this alteration.

3. To test system robustness outside the laboratory, we deployed one Sensor Web system inside a greenhouse which simulates the humid, moist environment of a rainforest. Another system will be deployed in Antarctica in late 2002.

C. SIGNIFICANCE OF RESULTS

The task developed a robust Sensor Web system capable of monitoring such diverse environments as the Southern California desert and Antarctica. The Antarctic Sensor Web will be deployed by Prof. Ralph Harvey's team in November, 2002 as a no-cost test of the system.

The GUI associated with the system has been recently deployed and field-tested at both the Huntington Gardens and Cal Poly Pomona. Real-time streaming data may be viewed at http://sensorwebs.jpl.nasa.gov/. This GUI capability allows the Sensor Web team to monitor the Sensor Webs' performance remotely, tracking both extreme environmental conditions and pod failure. For example, during the late summer, the internal temperature of some of the pods at the Huntington Garden rose to 65°C, yet the system did not fail and the communication links stayed synched despite the extreme degree of differential heating on the total Sensor Web system.

The work performed on this DRDF allowed for the solid development of a long-lived, robust system, and a means for shuttling the data back to the laboratory in real-time. This is a crucial and significant step in placing the system for actual applications, including environmental monitoring in harsh environments (Antarctica, Mars) and environmental remediation efforts.

D. FINANCIAL STATUS

The total funding for this task was $100,000, all of which has been expended.

E. PERSONNEL

The JPL Sensor Web team: Scott Burleigh (database management), Shannon Jackson (electronics), Dave Johnson (mechanical), Michael McAuley (servlet), and Richard Woodrow (applet) all contributed to the production of the system. Prof. Ralph Harvey (CWR) is deploying the system as a no-cost test in Antarctica.

F. PUBLICATIONS

1. Kevin A. Delin, "The Sensor Web: A Macro-Instrument for Coordinated Sensing," *Sensors,* **2**, 2002, pp. 270-285.

G. REFERENCES

[1] K.A. Delin and S.P. Jackson, "Sensor Web for *In Situ* Exploration of Gaseous Biosignatures," *Proceedings of 2000 IEEE Aerospace Conference*, Big Sky, MT March 2000. (see also http://sensorwebs.jpl.nasa.gov/resources/Delin-Jackson2000.pdf)

[2] K.A. Delin and S.P. Jackson, "The Sensor Web: A New Instrument Concept," *Proceedings of SPIE's Symposium on Integrated Optics*, San Jose, CA, January 2001. (see also http://sensorwebs.jpl.nasa.gov/resources/sensorweb-concept.pdf)