SMART MODULE FOR COMMUNICATIONS, PROCESSING, AND INTERFACE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a Continuation of U.S. patent application Ser. No. 14/147,676 filed on Jan. 6, 2014, and incorporated herein by reference; the present application also claims priority from Provisional U.S. Patent Application No. 61/921,298 filed on Dec. 27, 2013, and incorporated herein by reference.

STATEMENT OF GOVERNMENT INTEREST

The research that led to the development of the present invention was sponsored by the National Oceanic and Atmospheric Administration's (NOAA's) National Data Buoy Center (NDBC). NOAA is a part of the U.S. Department of Commerce, a component of the U.S. Federal government. The United States Government has certain rights in the present invention.

FIELD OF THE INVENTION

The present invention relates to a data collection and reporting system, particularly as used with data buoys and the like, for collecting environmental data. In particular, the present invention is directed toward a modular communications device, which may be readily retrofitted to a data buoy, weather station, or the like, in order to add additional data acquisition capabilities or other features, without disturbing existing communications and data logging equipment at the location.

BACKGROUND OF THE INVENTION

In a remote marine environment, a data collection and reporting system may be used to observe environmental conditions for weather warnings, forecasts, research, and the like. Buoys and weather stations are typically used with a system of various components to sense conditions, and record, process, and transmit data to shore-based receivers or other receiving electronics. These systems are usually composed of multiple hardware and software modules interfaced together and contained in one or more enclosures.

When new types of sensors, or processing schemes, are desired, changing the main processing and reporting system can be time-consuming and expensive because of the changes that are made to a complex system, and testing is required to check the changes and verify function of existing systems are not adversely impacted. It also adds risk of failure to the main environmental observation system until a sufficient amount of testing, perhaps months to years, is completed.

Buoy data acquisition systems and other remote data logging systems and networks are known in the art. Some examples of such systems are related technologies are disclosed below.

Houston et al., U.S. Pat. No. 6,536,272, issued Mar. 25, 2003, and incorporated herein by reference, discloses a water monitoring, data collection, and transmission module, which may be mounted to a ship or buoy, to collect data, process the data and then transmit the data by satellite to a remote central database.

Teng et al., U.S. Pat. No. 8,195,395, issued Jun. 5, 2013, and incorporated herein by reference, discloses a system for monitoring, determining and reporting directional spectra of ocean surface waves in near real-time from a moored buoy. This reference, which names an inventor in common with the present application, discloses a Prior Art data buoy sensor and uplink.

Smith, Published U.S. Patent Application No. 2013/0093625, published Apr. 18, 2013, and incorporated herein by reference, discloses adding a separate data system (in this case, a multilateration system for aircraft tracking) to existing data buoys.

Ishii, Published EP Patent Application 0 260 078, published Sep. 10, 1986, and incorporated herein by reference, discloses a data transmission method for ocean acoustic tomography.

Kolar, Published U.S. Patent Application 2012/0253746, published Oct. 4, 2012, and incorporated herein by reference, discloses an autonomous data quality system. The system monitors data from sensors, particularly remote, unattended sensors, to determine whether the sensor data is suspect.

Long-Term Autonomous Ocean Remote Sensing Utilizing the Wave Glider (Liquid Robotics) describes the wave glider product, which may be utilized in the present invention as a possible platform for a smart sensor. Liquid Robotics Wave Glider (2009) is a product brochure disclosing the basic features of the wave-glider autonomous ocean vehicle.

A Smart Sensor Web for Ocean Observation: Integrated Acoustics, Satellite Networking, and Predictive Modeling (Applied Physics Laboratory) describes an overall system, and despite the use of the terms "Smart" and "Integrated" does not really teach an integrated sensor, but rather integration of a number of disparate sensor types.

NDBC's Digital Directional Wave Module, (NOAA National Data Buoy Center, 2009), describes a directional wave measurement system called the Digital Directional Wave Module (DDWM). The present inventor is a co-author of this document. The reference is relevant to the extent it shows (FIG. **1**) a sensor and electronics mounted to a common module frame.

Integrated Sensor Package (Cognitive Environments) discloses an integrated sensor and electronics package comprising three stacked circuit boards. The device includes a Digi XBee series **2** radio configured as a router. A simple microprocessor runs a low-overhead task scheduler, Which manages multi-rate data acquisition and communication using the XBee radio module. The entire device is housed in a custom designed laser-cut housing. The device is intended for use in the Sensing and Communicating AIR project at the University College Falmouth (UK) as part of a building management system.

Iridium Products, (Iridium Everywhere) discloses a number of iridium related data logging and communications products. A few of the products, including the SVP Iridium Drifter, the iSphere and the 9602 Modem are deemed relevant to the present invention and are discussed in more detail below.

SVP Iridium Drifter, (MetOcean), describes an integrated drifting data buoy, which provides sensors, a controller, and an Iridium 9601 data transceiver, packaged into a drifting buoy. This reference illustrates how a limited number of sensors and an iridium modem can be put together into a standalone buoy.

iSPHERE, Oil and Spill and Current Tracking Buoy, (MetOcean) discloses a sealed sphere for tracking and monitoring oil spill incidents. The sphere includes an Iridium modem and transmitter, GPS tracker, and instrumentation to measure sea surface temperature data. Like the SVP Drifter discussed above, this reference is relevant in that it discloses an entire