

Provisional
Patent Application
WILDFIRE MONITORING SYSTEM USING
WIRELESS NETWORK

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Acknowledgment of Government Support

[01] This invention was made with Government support under Contract No. EAR-0121693 awarded by the National Science Foundation. The Government has certain rights to this invention.

Background Of The Invention

[02] Monitoring and sensing of uncontrolled fires, so-called "wildfires," is important to prevent damage to people, property and the environment. Information such as the position, direction and speed of a fire; wind, humidity, surface moisture, temperature and other data can help indicate what a fire is doing at a present moment, and can also be used to predict how the fire may behave in the near future. This information can be very valuable in extinguishing or controlling the fire and can also provide vital information for the safety of firefighters and the public.

[03] Accurate and comprehensive monitoring of wildfires can be difficult because the occurrence of fires is unpredictable and can take place anywhere over huge geographical areas thus making pre-installed sensors and networks impractical. Further, wildfires are unpredictable and can travel quickly so that deploying sensors in real time once a fire starts is difficult. The environment created by a wildfire is very harsh for sensitive sensors and telecommunication systems. Devices must operate in remote locations with limited power and communication ability.

[04] One type of system is described in U.S. Patent No. 5,734,335.

Summary of Embodiments of the Invention

[05] Embodiments of the invention provide a system for monitoring fire events and the conditions conducive to the initiation and evolution of wildfires in wildfire prone terrain.. In one embodiment, a plurality of devices are deployed in an area of expected fire spread or possible fire occurrence. Each device includes one or more sensors. Sensor data is sampled and communicated to a base station for relay to a computer processing system such as a collection of servers and clients interconnected with a network. Sensor data can be prioritized according to multiple and different criteria. Devices and sensors can be reconfigured and controlled by commands from the client computer systems.

[06] One embodiment provides a system for monitoring a fire, the system comprising: a plurality of devices, each with a plurality of sensors, wherein a priority is assigned to two or more sensors; a base station for communicating with the devices; and a processing system for receiving data from the sensors via the base station, wherein the data is received from the sensors according to the priority.

[07] Another embodiment provides a system for monitoring a fire, the system comprising: a plurality of devices, each with a plurality of sensors; a base station for communicating with the devices; a processing system for receiving data from the sensors via the base station; and a process executing on one or more of the devices for organizing a flow of data from the devices to the base station after deployment of the devices.

Brief Description of the Drawings

Figure 1 illustrates a basic configuration of a sensor monitoring system.

Detailed Description of Embodiments of the Invention

[08] Details of the invention are described in the accompanying papers as follows:

“Wireless Sensors for Wildfire Monitoring,” (8 pages) D. Doolin, N. Sitar;

“Rapid Prototyping and Deployment Chassis for Wireless Sensor Devices,” (3 pages) D. Doolin, N. Sitar, May 17, 2004; and

“Design and Construction of a Wildfire Instrumentation System Using Networked Sensors,” (1 page) M. Chen, C. Majidi, D. Doolin, S. Glaser, N. Sitar, June 17, 2003.

[09] Note the more-than-one-year prior to the filing date of this application of the last paper, above.

[10] Figure 1 shows a generalized arrangement of sensors, processors and telecommunication devices. Note that the specific number and arrangement of devices is only for purposes of illustration. In general, features of embodiments of the invention can work with any suitable types of network devices and network topology, protocol, communication links, etc. For example, communications among sensors 100 and base station 102 can be by radio frequency, infrared, hardwired or other arrangement. Protocols such as session initiation protocol (SIP), Internet protocol (IP), hyper-text transfer protocol (HTTP), etc., can be used. Processing performed by servers 106 and clients 104 can be by any suitable one or more processors that can work in real-time or non-real-time (e.g., batch, offline, etc.) modes; parallel or distributed processing, etc.

[11] In one embodiment, sensors 100 are deployed in an area of interest, such as an area that might be susceptible to a fire, or in the path of an advancing wildfire. Other types of deployment of sensors include attaching the sensors to a person, vehicle, structure, etc. In some cases, it may necessary or convenient to pre-install sensors, sensor networks and supporting network infrastructure such as base stations for satellite or cell communication. Deployment can be systematic, such as by regular, patterned placement by humans or machines; or arbitrary such as by thrown or dropped batches of sensors by land or air. Other types of deployment are possible. The capability of sensors to be rapidly deployed in difficult and adverse environmental conditions, as well as having such rapidly deployed sensors self-organize into networks and automatically interact with any pre-existing support infrastructure may provide critical information for property and life safety management during wildfire evolution.

[12] The sensors, or “motes,” include various types of sensors. For example, position, temperature, moisture or humidity, air pressure, force, light, and other sensors can all be used. A single mote can have multiple sensors and different motes can use different numbers and types of sensors than other motes. Depending on the type of application, different types of sensing may be more desirable than others, and sensor characteristics such as sensitivity, ruggedness, sample rate, power consumption, transmit/receive range, etc., may be more critical than others.

[13] Motes can have pre-programmed behavior so that the need for transmitting commands to a mote is reduced. Another option is to allow each mote to be reprogrammable so that mote behavior, such as sensor sampling rate, transmit range, communications relay ability, etc., can be adjusted from a control center. Mote firmware and software can be downloaded to each mote from a control center, server or other device.

[14] One embodiment of the invention uses base station 102 to send and receive signals among a network of motes that are in geographic proximity to the base station. The base station can be configured to perform different functions such as aggregating and correlating data, filtering data, monitoring motes, etc. A primary function of the base station is to act as a central radio-frequency receiver/transmitter and relay to servers 106 which, in turn, provide data from the motes to clients 104. Clients 104 can operate automatically or in interaction with human operators to analyze data, monitor and report on conditions, make predictions and issue commands to the motes via servers 106 and base station 102. Note that in practice several or many base stations can be used, each with an associated plurality of motes. Base station coverage can overlap to provide robustness via redundancy. Such overlapping coverage can also improve overall bandwidth of communications from and to motes.

[15] Sensors on motes can be prioritized so that if there is a lack of resources (e.g., limited bandwidth), the sensor readings with higher priority can be communicated first. Data of sensor types with lower priority can be buffered and transmitted when there is free bandwidth at a later time, or discarded and not sent at all. If a mote starts to become low on power, sensors with higher priority can remain active while lower priority sensors are shut down.

[16] Sensing can be triggered or controlled or modified in reaction to events or other criteria. For example, where a concentration of a toxic or dangerous gas such as carbon monoxide is being sensed a mote can be programmed to report infrequently on concentrations below a predetermined level. If concentration exceeds a threshold (e.g., maximum safe exposure time is 2 hours or less) then the mote can send the sampling or an alert message at a high priority. The mote can begin sampling the carbon monoxide level more frequently and give the appropriate sensor a higher priority. When the condition becomes safe (i.e., does not exceed the threshold) the mote and sensing operation can go back to the previous state. One sensor reading can be used to modify the operation and reporting of other sensors. For example, if temperature increases then harmful gas monitoring can be increased in frequency, reporting, priority, etc.

[17] Motes and sensors can be applied to movable objects such as firefighters and vehicles. One embodiment of the invention uses fire equipment such as fire engines to provide base station support for motes deployed in the terrain, on the fire fighters, and on fire fighting vehicle. The motes may be used to collect environmental data at each fire fighter's location, and report data collect from sensors measuring physical condition of fire fighters, such as body temp, etc. Base stations can also be made mobile as where base station functionality is carried in a vehicle, remotely operated vehicle (i.e., "drone"), etc.

[18] Another embodiment of the invention uses a mobile base station attached to a fire fighter which communicates via long distance radio, satellite etc. as a relay to communicate to back end servers. Base stations can be pre-deployed to collect data from mobile motes mounted on fire fighters, which interact with previously or concurrently deployed stationary motes.

[19] Although the invention has been discussed with respect to specific embodiments thereof, these embodiments are merely illustrative, and not restrictive, of the invention. For example, although specific sensor types have been discussed, any type of sensor can be included in a mote. Additional types of sensors include imaging sensors (e.g., cameras), chemical detectors, infrared sensing, etc. Any type of software applications or functionality can be provided at the mote, base station, servers and clients.

It is anticipated that third-party commercial software can be used to perform functions such as database storage and retrieval, data transfer, data analysis, operating system functions, etc.

[20] Although embodiments of the invention have been presented primarily with respect to wildfires, other uses are possible. For example, the system can be used during controlled burns, firefighter training, monitoring chemical or biological contamination movement and spread, etc.

[21] In the description herein, numerous specific details are provided, such as examples of components and/or methods, to provide a thorough understanding of embodiments of the present invention. One skilled in the relevant art will recognize, however, that an embodiment of the invention can be practiced without one or more of the specific details, or with other apparatus, systems, assemblies, methods, components, materials, parts, and/or the like. In other instances, well-known structures, materials, or operations are not specifically shown or described in detail to avoid obscuring aspects of embodiments of the present invention.

[22] Reference throughout this specification to “one embodiment”, “an embodiment”, or “a specific embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention and not necessarily in all embodiments. Thus, respective appearances of the phrases “in one embodiment”, “in an embodiment”, or “in a specific embodiment” in various places throughout this specification are not necessarily referring to the same embodiment. Furthermore, the particular features, structures, or characteristics of any specific embodiment of the present invention may be combined in any suitable manner with one or more other embodiments. It is to be understood that other variations and modifications of the embodiments of the present invention described and illustrated herein are possible in light of the teachings herein and are to be considered as part of the spirit and scope of the present invention.

[23] It will also be appreciated that one or more of the elements depicted in the drawings/figures can also be implemented in a more separated or integrated manner, or even removed or rendered as inoperable in certain cases, as is useful in accordance with a particular application.

[24] As used in the description herein and throughout the claims that follow, “a”, “an”, and “the” includes plural references unless the context clearly dictates otherwise. Also, as used in the description herein and throughout the claims that follow, the meaning of “in” includes “in” and “on” unless the context clearly dictates otherwise.

[25] The foregoing description of illustrated embodiments of the present invention, including what is described in the Abstract, is not intended to be exhaustive or to limit the invention to the precise forms disclosed herein. While specific embodiments of, and examples for, the invention are described herein for illustrative purposes only, various equivalent modifications are possible within the spirit and scope of the present invention, as those skilled in the relevant art will recognize and appreciate. As indicated, these modifications may be made to the present invention in light of the foregoing description of illustrated embodiments of the present invention and are to be included within the spirit and scope of the present invention.

[26] Thus, while the present invention has been described herein with reference to particular embodiments thereof, a latitude of modification, various changes and substitutions are intended in the foregoing disclosures, and it will be appreciated that in some instances some features of embodiments of the invention will be employed without a corresponding use of other features without departing from the scope and spirit of the invention as set forth. Therefore, many modifications may be made to adapt a particular situation or material to the essential scope and spirit of the present invention. It is intended that the invention not be limited to the particular terms used in following claims and/or to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include any and all embodiments and equivalents falling within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A system for monitoring a fire, the system comprising:
a plurality of devices, each with a plurality of sensors, wherein a priority is assigned to two or more sensors;
a base station for communicating with the devices; and
a processing system for receiving data from the sensors via the base station, wherein the data is received from the sensors according to the priority.
2. The system of claim 1, wherein the priority is predetermined at a time of deployment of a device.
3. The system of claim 1, wherein the priority is set after a time of deployment of a device.
4. The system of claim 1, further comprising:
a process executing at a device for preventing operation of a sensor depending on a criterion.
5. The system of claim 4, wherein the criterion includes a determination of a low-power condition.
6. The system of claim 4, wherein the criterion includes a determination of a restricted bandwidth condition.
7. A system for monitoring a fire, the system comprising:
a plurality of devices, each with a plurality of sensors;
a base station for communicating with the devices;
a processing system for receiving data from the sensors via the base station; and
a process executing on one or more of the devices for organizing a flow of data from the devices to the base station after deployment of the devices.
8. The system of claim 7, wherein the devices are pre-deployed in an area.
9. The system of claim 7, wherein the devices are dynamically deployed during a fire event.
10. The system of claim 7, wherein data collection priorities are modified.
11. The system of claim 10, wherein data collection priorities are modified according to a data type.
12. The system of claim 10, wherein data collection priorities are modified according to a data collection rate.

13. The system of claim 10, wherein data collection priorities are modified according to fire conditions.

14. A system for monitoring a plurality of mobile objects, the system comprising:
a plurality of devices coupled to the mobile objects, wherein each device includes a plurality of sensors, wherein the sensors include environmental and health sensors;
a base station for communicating with the devices;
a processing system for receiving data from the sensors via the base station; and
a process executing on one or more of the devices for organizing a flow of data from the devices to the base station after deployment of the devices.

15. The system of claim 14, wherein a mobile object includes a person.

16. The system of claim 14, wherein a mobile object includes a vehicle.

17. The system of claim 14, wherein the base station is mobile.

18. The system of claim 14, wherein data collection priorities are modified.

19. The system of claim 14, wherein data collection priorities are modified according to data type.

20. The system of claim 14, wherein data collection priorities are modified according to data collection rate.

21. The system of claim 14, wherein data collection priorities are modified according values of data collected.

ABSTRACT OF THE DISCLOSURE

Embodiments of the invention provide a system for monitoring fire events. In one embodiment, a plurality of devices are deployed in an area of expected fire spread or possible fire occurrence. Each device includes one or more sensors. Sensor data is sampled and communicated to a base station for relay to a computer processing system such as a collection of servers and clients interconnected with a network. Sensor data can be prioritized according to different criteria. Devices and sensors can be reconfigured and controlled by commands from the client computer systems.

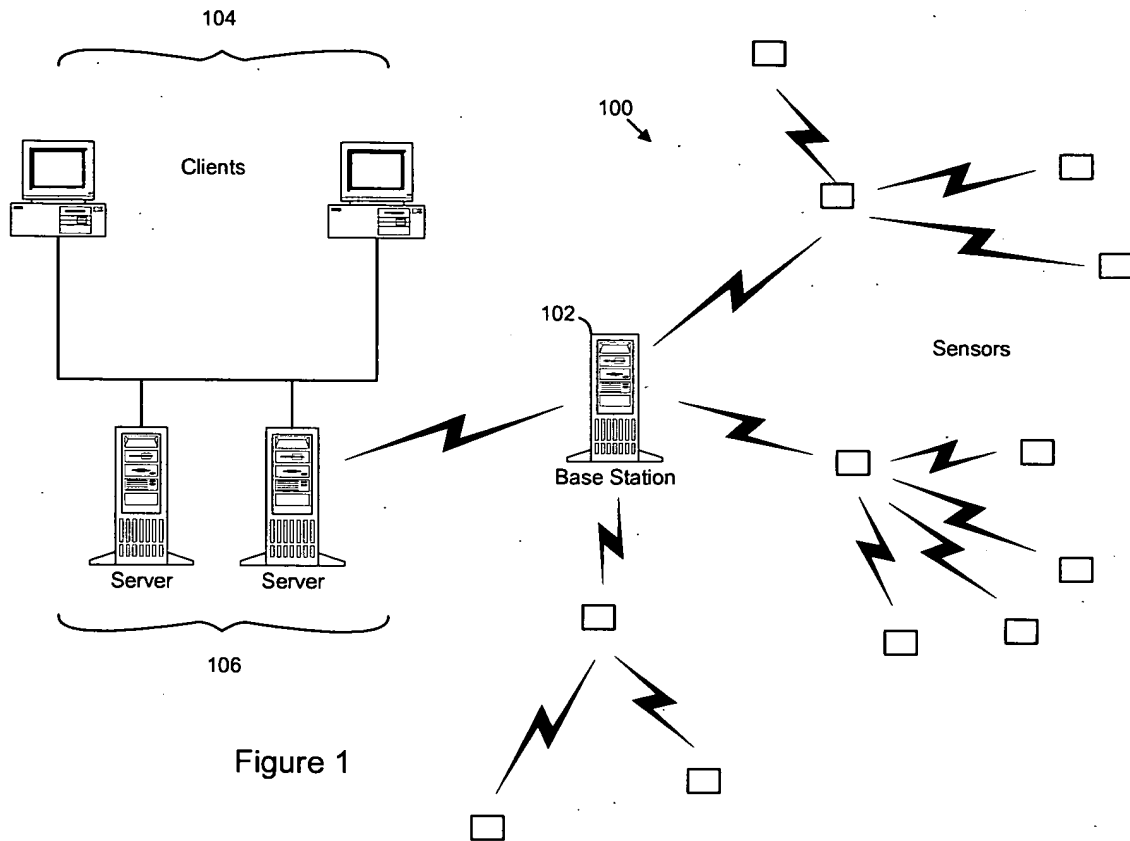


Figure 1