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Role of Environmental Sensors in Environmental Monitoring Systems

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Abstract — Environmental sensors are pivotal in environmental monitoring systems, gathering data on diverse parameters and conditions within the natural world. These sensors serve as vital elements within monitoring networks, furnishing critical insights for scientific inquiry, resource stewardship, pollution mitigation, and public health initiatives. They stand as indispensable instruments for safeguarding the environment, human well-being, and societal welfare. Through furnishing precise and dependable data, environmental sensors guide decision-making processes and bolster the adoption of sustainable practices,fostering a more robust and healthier planet.

Index Terms—environmental, instruments, planet, sensors

I. INTRODUCTION

Environmental sensors play a crucial role in environmental monitoring systems by gathering data on various parameters within the environment. These sensors are designed to detect and measure physical, chemical, and biological elements present in air, water, soil, and other mediums. The data collected by these sensors is essential for assessing environmental quality, detecting pollution, and informing decision-making processes related to environmental management and conservation. Here are some key roles of environmental sensors in monitoring systems:

1. Data Collection [1] [8]: Environmental sensors collect real-time or periodic data on parameters such as temperature, humidity, air quality, water quality, noise levels, radiation levels, and more. This data provides insights into the current state of the environment and helps in identifying trends or changes over time.
2. Early Warning Systems : Environmental sensors can detect anomalies or sudden changes in environmental parameters, serving as early warning systems for natural disasters such as floods, earthquakes, tsunamis, and forest fires. This early detection capability can help in minimizing damage and saving lives.
3. Pollution Monitoring : Environmental sensors are instrumental in monitoring pollution levels in air, water, and soil. They can detect pollutants such as particulate matter, gases, heavy metals, and organic compounds, helping in assessing the extent of pollution and identifying its sources.
4. Resource Management : Sensors play a vital role in managing natural resources such as water and energy. They can monitor water levels in rivers, lakes, and reservoirs, track energy consumption in buildings, and optimize resource usage for sustainability and efficiency.
5. Biodiversity Monitoring [7]: Environmental sensors can also monitor biological parameters such as biodiversity, species populations, and habitat conditions. This data is essential for conservation efforts and understanding the impacts of environmental changes on ecosystems.
6. Remote Sensing : Some environmental sensors are designed for remote sensing applications, allowing monitoring of vast and remote areas that are otherwise difficult to access. Satellite-based sensors, for example, can provide valuable data on global environmental trends and phenomena.
7. Data Integration and Analysis [1] [8]:Environmental sensors generate large volumes of data, which can be integrated and analyzed using advanced technologies such as artificial intelligence and machine learning. This analysis helps in identifying patterns, correlations, and insights that inform decision-making processes for environmental management and policy development.

II. TYPES OF ENVIORNMENTAL SENSORS

Environmental sensors encompass a range of monitoring devices designed to assess and evaluate environmental quality. These sensors comprise soil sensors, temperature and humidity sensors, gas sensors, rainfall sensors, light sensors, wind speed, and direction sensors, among others. They not only accurately measure environmental parameters but also enable the testing, recording, and storage of data.

A. Temperature and humidity sensors [11] [12] are instrumental devices utilized for measuring and monitoring temperature and humidity levels in various environments. These sensors play a crucial role in providing accurate and reliable data essential for a wide range of applications, including climate control, weather forecasting, indoor air quality monitoring, and industrial processes.

B. Air quality sensors are essential tools used to monitor and assess the levels of various pollutants and contaminants present in the air. These sensors detect and measure pollutants such as particulate matter (PM), volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen dioxide (NO2), sulphur dioxide (SO2), and ozone (O3), among others. By continuously monitoring air quality, these sensors provide valuable data for environmental monitoring, public health, urban planning, and policy-making efforts aimed at improving air quality and reducing pollution-related health risks.

C. Soil sensors [13] are specialized instruments designed to measure and monitor various parameters and properties of soil. These sensors play a critical role in agriculture, environmental monitoring, and soil science research. Soil sensors can measure a wide range of soil characteristics, including moisture content, temperature, pH level, nutrient levels etc.

D. Rainfall sensors are specialized devices used to measure and monitor precipitation, particularly rainfall. These sensors are essential for meteorological observations, hydrological studies, flood forecasting, and agricultural planning.

E. Water level and pressure sensors [4] are critical instruments used to measure and monitor the levels and pressure of water in various applications, including environmental monitoring, hydrology, industrial processes, and water resource management. These sensors play a crucial role in ensuring the efficient and safe operation of water-related systems.

F. Gas sensors [6] [9] are devices used to detect and measure the concentration of gases in the atmosphere or within enclosed spaces. These sensors are vital for monitoring air quality, ensuring workplace safety, and detecting potential hazards in various environments. Gas sensors operate based on different principles, including chemical reaction, optical absorption, and conductivity.

G. Noise sensor, also known as a sound sensor or acoustic sensor, is a device designed to detect and measure sound levels in the environment. These sensors are used in various applications, including environmental monitoring, industrial noise control, smart cities, and consumer electronics. Noise sensors operate by converting sound waves into electrical signals, which can then be processed and analyzed to determine the intensity, frequency, and characteristics of the sound.

III. LITERATURE SURVEY

A Wearable Multi-sensor IoT Network System for Environmental Monitoring is a technology aimed at monitoring various environmental parameters using wearable devices equipped with multiple sensors connected through the Internet of Things (IoT). The wearable system [1] enables real-time data collection, analysis, and transmission for environmental monitoring purposes. The paper presents a low-power wearable sensor node for environmental IoT applications that can monitor and transmit environmental data reliably, addressing the need for indoor environmental monitoring due to health concerns. The wearable sensor node successfully monitors environmental data and reliably transmits it to a remote cloud server, indicating effective environmental monitoring. The methodology involved developing a low-power wearable sensor node for environmental IoT applications, forming a wireless sensor network based on XBee, monitoring environmental data, transmitting data to a remote cloud server, displaying data through a web-based application, and conducting experiments to validate system reliability.

The intelligent robotic sensor agents [2] are used to collect data and the collected sensor data are fused in a world model, which is available to remote human supervisors as an interactive virtual virtualized reality environment model. The paper discusses the development of a wireless network of mobile autonomous Robotic Intelligent Sensor Agents for investigating environmental parameters, with collected sensor data fused into a world model accessible to remote human supervisors in a virtual reality environment. The methodology involves developing a wireless network of mobile autonomous Robotic Intelligent Sensor Agents for investigating environmental parameters, with collected data fused into a world model and made available to remote human supervisors in a virtual environment. The dataset used in the study is the sensor data collected by the mobile autonomous Robotic Intelligent Sensor Agents for investigating multiple environmental parameters.

Environmental electronic sensing systems [3] have been created to automate measurement tasks that are difficult for humans to repeat in a precise and synchronous fashion. The paper discusses the historical development of environmental measurement instrumentation, the role of electronic sensing systems in automating measurements, and the importance of sensor networks for obtaining areal measurements of environmental processes. Environmental electronic sensing systems automate measurement tasks, enable predictions, and calibrate satellite remote sensing data. The methodology involves using environmental electronic sensing systems to automate measurements, collecting data at regular time steps for mathematical modeling, analyzing data at different scales statistically, using point measurements for calibration/validation, and combining sensor measurements with fusion algorithms.

For monitoring the environmental parameters, cost-effective sensors [4] and sensor nodes are deployed. The paper reviews the design and characterization of humidity and pH sensors manufactured using different technologies, emphasizing the importance of manufacturingmethods on sensor performance and cost, as well as the development of a wireless sensor node for monitoring environmental parameters. The methodology involved designing and characterizing humidity and pH sensors using various manufacturingtechnologies such as PCB, ink-jet, and screen printing. The sensors were manufactured using ink-jet printing and spin-coating. An interdigitated electrode (IDE) TiO_2 thick-film based pH sensor was designed, manufactured, and characterized, along with implementing a pH measurement system based on the integrated circuit AD5933. The dataset used in the study includes a TiO_2-based sensor integrated into a wireless sensor node for monitoring environmental parameters such as pH, temperature, relative humidity, and volatile organic compounds.

Environmental sensors and networks of sensors [5] are transforming everyday life by scrutinizing our environment and sometimes feeding into control systems that then adjust our environment to improve our processes and lives. The paper discusses how environmental sensors and networks are transforming everyday life by scrutinizing the environment and feeding into control systems to improve processes and lives. Environmental sensors and networks play a transformative role in monitoring and adjusting the environment to enhance processes and quality of life.

The infrared sensors [6] combine a new kind of infrared multilayer filter, solid state Fabry-Perot filters, with narrow bandpass IR optical filters and a pyroelectric detector array. The paper discusses the development of environmental compact infrared sensors that combine various technologies like infrared multilayer filters, Fabry-Perot filters, IR optical filters, and pyroelectric detector arrays, with a focus on analyzing infrared parameters of pyroelectric materials, selecting the gas to sensor, and designing the sensor system. The methodology in the paper includes the study of infrared parameters of pyroelectric materials, study, and selection of the gas to sensor, and the design and study of properties of the system sensor. The main outcomes measured in the study are the infrared parameters of pyroelectric materials, gas selection for the sensor, and properties of the system sensor.

Environmental sensor networks have been established and large new networks are planned for monitoring multiple habitats at many different scales. The paper discusses the capabilities and applications of environmental sensor networks, ranging from global monitoring to local habitat measurements, emphasizing the integration of various sensor systems for a comprehensive understanding of ecological systems [7] and the advancements in sensor technology. Environmental sensor networks offer distributed sensing capacity, real-time data visualization, and integration with adjacent networks.

The methodology involves the establishment of environmental sensor networks for monitoring habitats at various scales, integrating various sensor systems and emerging technologies for a comprehensive understanding of ecological systems.

The paper presents three IoT-based wireless sensors [8] for environmental monitoring, highlighting their feasibility for implementing monitoring applications. The paper discusses how recent advancements in IoT support environmental data transmission, the systems enable remote data recording and visualization, and the developed systems are feasible for monitoring applications.

Implementation of environmental monitoring and greenhouse control using [9] a sensor network, including hardware for periodic monitoring and control of greenhouse gases, with a future focus on applying the same mechanism using a wireless sensor network. The paper discusses environmental monitoring and greenhouse control using a sensor network, focusing on periodic monitoring and control of greenhouse gases in an enhanced manner. The main finding of the paper is the application of environmental monitoring and greenhouse control using a sensor network, with future work aimed at implementing the mechanism using a wireless sensor network.

The creation of a sensoric network and digital platform to improve life in the city and advance Smart Life technologies is depicted in [10]. The network includes low-cost sensors at over two hundredlocations, with parameters described, and a platform for data processing based on open-source principles. The study aimed to improve life in the city and build capacity in Smart Life technologies by designing a sensoric network with low-cost sensors at over two hundred locations and a platform based on open- source principles for data processing. The methodology involved designing a sensoric network with low-cost sensors at over two hundred locations in the city, describing the sensor parameters, and designing a platform for data collection, processing, and interpretation based on open-source principles.

REFERENCES

[1] Fan Wu, Christoph Rüdiger, Jean-Michel Redouté, Mehmet Rasit Yuce, “A Wearable Multi-sensor IoT Network System for Environmental Monitoring”, 12th International Conference on Body Area Networks, China, September 2017

[2] E.M. Petriu; G.G. Patry; T.E. Whalen; A. Al-Dhaher; V.Z. Groza, “Intelligent robotic sensor agents for environment monitoring”, 2002 IEEE International Symposium on Virtual and Intelligent Measurement Systems (IEEE Cat. No.02EX545), May 2002

[3] Nicholas J. Kinar, John W. Pomeroy, “Environmental Electronic Sensing Systems”, 28 JULY 2021, DOI: 10.1093/OBO/9780199874002-0231

[4] Dragana Vasiljevic, Cedo Zlebic, Goran Stojanovic, Zoran Stamenkovic, “Cost-Effective Sensors and Sensor Nodes for Monitoring Environmental Parameters”, Article in FACTA UNIVERSITATIS Series Electronics and Energetics · March 2018

[5] David Sanders, “Environmental sensors and networks of sensors”, ISSN: 0260-2288, publication date: 12 September 2008

[6] J. de Frutos; A.M. Gonzalez; M.C. Duro; F. Lopez; J. Meneses; A.J. de Castro, “New environmental infrared sensors”, ISAF 1998. Proceedings of the Eleventh IEEE International Symposium on Applications of Ferroelectrics (Cat. No.98CH36245)

[7] Philip W. Rundel, Eric A. Graham, Michael F. Allen, Jason C. Fisher, Thomas C. Harmon, “Environmental sensor networks in ecological research”, 16 April 2009, https://doi.org/10.1111/j.1469-8137.2009.02811.

[8] George Mois; Silviu Folea; Teodora Sanislav, “Analysis of Three IoT-Based Wireless Sensors for Environmental Monitoring”, IEEE Transactions on Instrumentation and Measurement (Volume: 66, Issue: 8, August 2017)

[9] S. R. Boselin Prabhu, S. Sophia, P. Balamurugan, “Environmental Monitoring and Greenhouse Control by Distributed Wireless Sensor Network”, Scholars Journal of Engineering and Technology (SJET), Sch. J. Eng. Tech., 2014; 2(4A):511-516

[10] Peter Bronis, Igor Balazovic, Peter Kassák,

"Environmental Sensors in The World of Smart Life Technologies", Conference: 2021 International Conference on ICT for Smart Society (ICISS), August 2021, DOI: 10.1109/ICISS53185.2021.9533260

[11] Azimi Mahmud, M.S.; Buyamin, S.; Mokji, M.M.; Abidin, M.S.Z. Internet of Things based Smart Environmental Monitoring for Mushroom Cultivation. Indones. J. Electr. Eng. Comput.Sci. 2018, 10, 847,doi:10.11591/ ijeecs.v10.i3. pp847-852.

[12] Mohanraj, I.; Ashokumar, K.; Naren, J. Field Monitoring and Automation Using IOT in Agriculture Domain. Procedia Comput. Sci. 2016, 93, 931–939, doi:10.1016/j.procs. 2016.07.275.

[13] Karimah, S.A.; Rakhmatsyah, A.; Suwastika, N.A. Smart pot implementation using fuzzy logic. J. Phys. Conf. Ser. 2019, 1192, 012058, doi:10.1088/1742-6596/1192/1/012058.

[14] Kim, T.H.; Solanki, V.S.; Baraiya, H.J.; Mitra, A.; Shah, H.; Roy, S. A smart, sensible agriculture system using the exponential moving average model. Symmetry (Basel) 2020, 12, 457, doi:10.3390/sym12030457.

[15] Sarat Chandra, G.; Srinivas Ravi, K. Effective Architecture for Greenhouse Controlling and Monitoring using Wi-Fi Peer to Peer Direct Protocol. Indian J. Sci. Technol. 2016, 9, doi:10.17485/ijst/2016/v9i17/92975.

[16] Taskin, D.; Yazar, S. A Long-range context-aware platform design for rural monitoring with IoT In precision agriculture. Int. J. Comput. Commun. Control 2020, 15, 1–11, doi:10.15837/IJCCC.2020.2.3821.

[17] Alpay, Ö.; Erdem, E. The Control of Greenhouses Based on Fuzzy Logic Using Wireless Sensor Networks. Int. J. Comput. Intell. Syst. 2018, 12, 190, doi:10.2991/ijcis.2018.125905641.