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Wireless Sensor Network for Soil Fertility Monitoring

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Summary



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- **Introduction.**
- **Formulation of the problem.**
- **Justification,**
- **Theoretical aspects of the subject.**
- **Wireless sensor network requirements.**
- **Objectives and design requirements.**
- **Design proposal.**
- **Network proposal.**
- **Practical applications.**
- **Future works.**

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Introduction.

- **The man has an important influence on the deterioration of the environment.**
- **Inadequate attention to the soil can affect the composition of soil nutrients.**
- **Therefore, it is very important to monitor the soil nutrient composition and the climatic variables of the area of interest.**




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Formulation of the problem.


- **To monitor the environment it is necessary to locate a significant amount of sensors in the field.**
- **It will be necessary to locate automatic mini-weather stations in the monitoring area.**
- **The system will have to manage a significant amount of data according to the dimensions of the terrain and the accuracy that is desired.**




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Justification




- **To know the dynamic behavior of these variables.**
- **Possibility of controlling nutrient composition and irrigation in a differentiated way (Precision Farming).**
- **The system will be scalable and spatially adaptable with respect to the terrain it monitors.**
- **The amount of data it provides, it facilitates the soil analysis and the environment.**



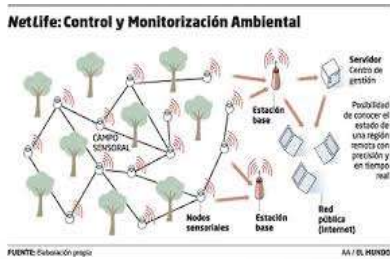
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Theoretical aspects of the subject. Wireless sensor network.




- **The objective is the wireless transmission of data from the environment to the processing site.**
- **It consists of elements called nodes with different functions.**
- **The elements that constitute it are:**
 - **Sensor node.**
 - **Router Node .**
 - **Coordinating node or Gateway.**
- **Generally the nodes have processing modules.**
The figure shows a WSN associated with environmental monitoring.




FUENTE: Elaboración propia AA / EL MUNDO

¿Qué es el marco teórico?




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Sensor Node




- To transform the physical or chemical variables into electrical (voltage or current).
- The type of sensor depends on the chemical and climatological variables that are measured.
- They have: microcontroller, an RF radio transceiver and power supply.
- The proposed standard is the module NRF24L01 (2.4GHz to 2.5 GHz).
- The module have an internal and external antenna.
- With external antenna has bigger distance (1Km).
- Two AAA batteries with a capacity of 2,500mAh are used in the power source.




Humidity




Conductivity probe



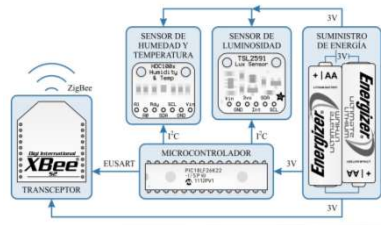
NRF24L01



PH Sensor




Humidity and temperature Sensors




Electronic diagram

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Router



- Its function is to transmit the data to the final devices of the system.
- Its hardware is similar to the sensor, but with greater computing power to perform simple calculation and logic algorithms.
- It has sensors to make measurements that are necessary in the place where they are located.
- The scalability is obtained by repeating the topology of these three nodes.
- As an example, a wireless router of a home WLAN is shown in the following figure.






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Coordinating Node or Gateway


- It consists of a low-cost mini-computer with a single board (Raspberry Pi development board).
- It is necessary to store the data in a SD card.
- Data format: nutrients concentration (N, P and K), climatic variables, spatial location of the sensor, date and time.
- You can incorporate a video camera with a visible spectral, or multi-spectral.



GATEWAY



Raspberry Pi 1 A+



Raspberry Pi 1 B+


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Data collection

- Data is collected and then displayed and / or analyzed.
- The analysis guarantees the necessary supply of nutrients, avoiding the saturation of the soil.




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The base station.

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- **It connects to the Gateway nodes to collect the data.**
- **Formed by a computer, or hardware devices with an important computing power.**
- **The base station, can display the collected data.**



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Wireless sensor network requirements

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- **Tolerance to the fail: can be dynamically reconfigured if it is damaged. Reorganization of the nodes.**
- **Scalability: the protocol supports any size and number of nodes.**
- **Supports aggressive environments: protocols are resistant to these conditions.**
- **Security: with access control that detect intrusion and anomalies.**


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Objetives and design requirements.

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- **Determine the monitored area.**
- **Select the types of sensors.**
- **Decide the necessary computing power.**
- **Determine, the communication standards most convenient.**



designed by freepik

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Design proposal


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- **The network will use the known elements: sensor, router and Gateway.**
- **The star topology is chosen, to locate the sensors around the routers and the distance among them depends on the area that requires covering and the sensors density.**
- **The Gateway is located in the center of the field under test, where it can receive data, from the sensors that are sent through the routers.**
- **The Gateway includes a weather station.**

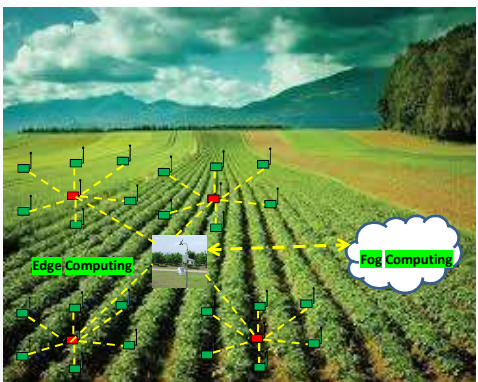
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


Network proposal.




- The sensor nodes (green boxes) are connected to the routers (red boxes) wirelessly (yellow dashed lines).
- It is a scalable topology, feasible to expand the terrain to be covered, just by repeating the topology.






Router




Node Sensor

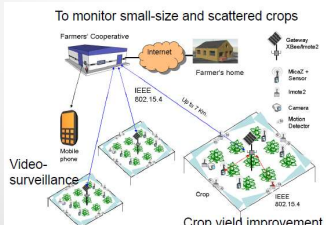
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Practical applications.




- It allows the farmer to manage the variability of nutrients in their parcels (PA).
- The Smart Orchard technique performs cultural attention (planting and watering) automatically.
- The Smart Orchard is used in small parcels and in domestic crops (urban farming).



Wireless sensor network.



Precision Farming





Urban agriculture


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Future works

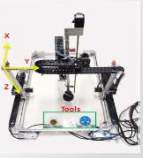
 

- Use of drones to expand the monitored area.
- It is a variant of greater spatial flexibility and scalability.
- In the vehicles we locate the spectral cameras, for more complete studies.
- Teach a subject associated with electronic environmental monitoring systems.
- The subject has topics associated with: precision and urban farming and the technology used for this.


Camera multispectral


Drone for farming precision


Farming Robot



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