A multi-hop wireless sensor network for in-situ agricultural applications

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Abstract

This paper presents the design and implementation of a wireless sensor network (WSN) for agricultural monitoring applications using a multi-hop tree based architecture. Each sensor node is equipped with different sensors such as soil moisture (custom built), atmospheric temperature and relative humidity sensors. The nodes use TelosB modules for wireless communication. The implemented testbed consists of 20 nodes covering an area of 120 m × 150 m. Each node reported its sensor data at every 1 hour interval to the base station along the data collection tree following a time syn- chronized periodic sleep wake-up schedule. The maximum depth of the constructed data collection tree was observed as 5 hops in the implemented network. The performance of the in-house developed soil moisture sensors are evaluated through the implemented WSN and the difference between the measured soil moisture and the commercial time domain reflectometry is observed as ±3%.

Important Notes:

Several researchers have employed WSNs to collect periodic measurements from their agricultural fields. A review of various sensor network implementations for precision agriculture is presented in [9]. ZigBee (which uses IEEE 802.15.4 protocol) and LoRa [9] are the preferred wireless technologies for agricultural applications because of their low power consumption and communication range. The solutions which are designed for agricultural domain in developing countries need to be affordable and easy to use. Star networks of sensor nodes using ZigBee devices are discussed in [10] and [11] for irrigating the agricultural fields. However, a multi-hop wireless network architecture is essential to cover large farms.

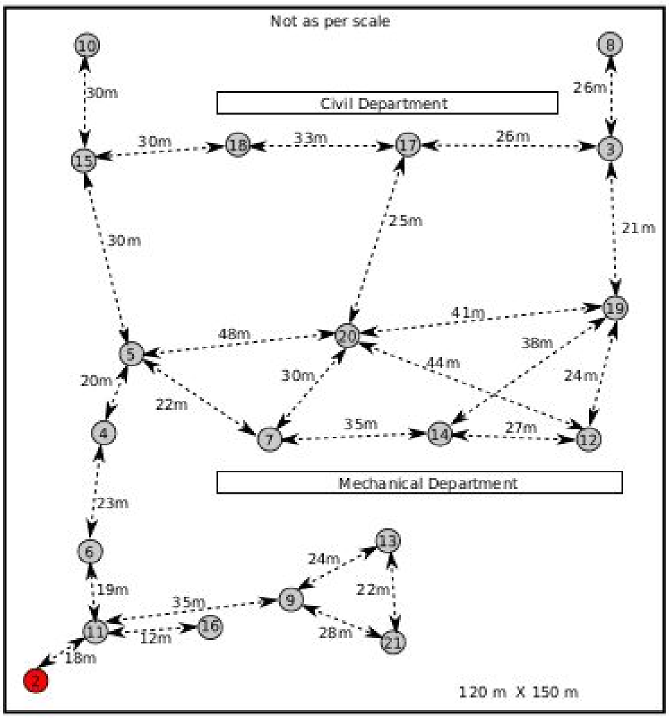

Figure 5. Placement of nodes

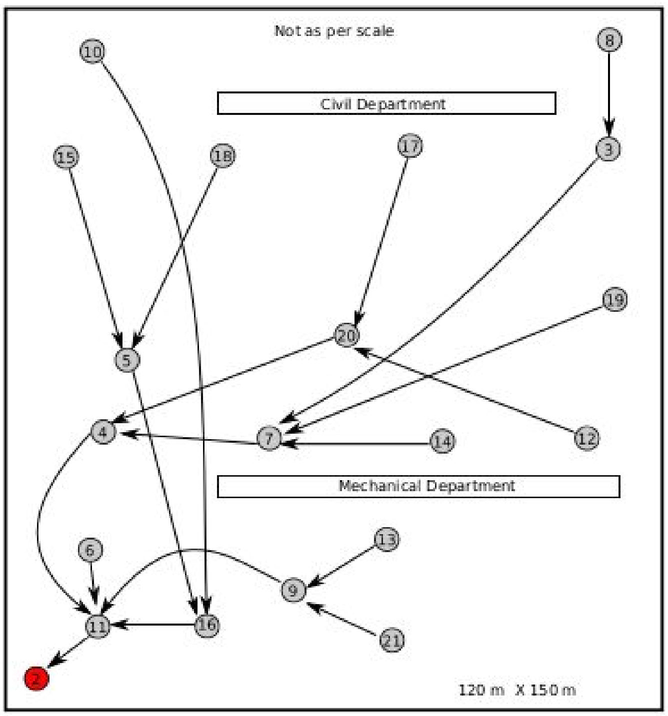

Figure 7. Tree used for the data collection

http://www.ursi.org/proceedings/procAP19/papers2019/AmultihopwirelesssensornetworkforinsituagriculturalapplicationsPID5639365.pdf

Agro-sense: Precision agriculture using sensor-based wireless mesh networks

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Abstract:
Advances in wireless personal area networks have made the practical deployment of various services possible, which until a few years ago was considered extremely costly or labor intensive. We build such a wireless sensor network for precision agriculture where real time data of the climatologieal and other environmental properties are sensed and relayed to a central repository. The architecture comprises of three distinct sections - (a) the sensor-nodes (b) the wireless mesh network and (c) the actuation components. The sensors are selected based on the properties suited for the most common crops and we identify four such attributes. The sensor network is based on the IEEE-802.15.4(**) standard and we develop a new static routing algorithm suited for the sensing application. The algorithm overrides the deficiency of the Hierarchical Routing scheme inherent in the ZigBee specification where the C_{sklp} addressing algorithm limits the possible depth of the network topology due to address wastage. The new algorithm maintains the hierarchical network topology and thus ensures routing at its optimal best. The algorithms for both addressing and routing are provided. The actuation components are also a part of mesh network and are activated wirelessly for controlling irrigation and fertigation.

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https://ieeexplore.ieee.org/abstract/document/4542291/authors#authors
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****IEEE 802.15.4** is a technical standard which defines the operation of low-rate wireless personal area networks (LR-WPANs). It specifies the physical layer and media access control for LR-WPANs, and is maintained by the IEEE 802.15 working group, which defined the standard in 2003.[1] It is the basis for the Zigbee,[2] ISA100.11a,[3] WirelessHART, MiWi, 6LoWPAN, Thread and SNAP specifications, each of which further extends the standard by developing the upper layers which are not defined in IEEE 802.15.4. In particular, 6LoWPAN defines a binding for the IPv6 version of the Internet Protocol (IP) over WPANs, and is itself used by upper layers like Thread.

Design of a low-cost Wireless Sensor Network with UAV mobile node for agricultural applications

Authors: Jose Polo, Gemma Hornero, Coen Duijneveld, Alberto García, OscarCasas

Highlights

•A sensor network has been developed to be used in extensive fields.

•Nodes are scattered around the field and cannot connect directly each other.

•A mobile node and an UAV have been designed to collect the data from the ground nodes.

•Main functions: send video and telemetry, transports a substance to be scattered.

•Total cost is around $900, low enough to introduce in any agricultural application.

Abstract

The aim of the present paper is to propose an agricultural environment monitoring server system utilizing a low-cost Wireless Sensor Network (WSN). Several sensor nodes are scattered in fields several kilometers in size, and we propose collection of the information stored in the nodes by a mobile node, or mule. To cover long distances in a short period of time, we use an unmanned aerial vehicle (UAV), which retrieves the data stored in the ground nodes. In addition, the UAV may be used to acquire additional information and to perform actions. Its elevated position allows observation of the field with a perspective that is useful for detecting changes affecting crops, such as pests, diseases, significant changes in soil moisture, drought or floods.

https://www.sciencedirect.com/science/article/pii/S0168169915002999

A survey on wireless sensor network infrastructure for agriculture

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Abstract

The hybrid wireless sensor network is a promising application of wireless sensor networking techniques. The main difference between a hybrid WSN and a terrestrial wireless sensor network is the wireless underground sensor network, which communicates in the soil. In this paper, a hybrid wireless sensor network architecture is introduced. The framework to deploy and operate a hybrid WSN is developed. Experiments were conducted using a soil that was 50% sand, 35% silt, and 15% clay; it had a bulk density of 1.5 g/cm^3 and a specific density of 2.6 cm^{-3}. The experiment was conducted for several soil moistures (5, 10, 15, 20 and 25%) and three signal frequencies (433, 868 and 915 MHz). The results show that the radio signal path loss is smallest for low frequency signals and low moisture soils. Furthermore, the node deployment depth affected signal attenuation for the 433 MHz signal. The best node deployment depth for effective transmission in a wireless underground sensor network was determined.

Highlights

► Introduce the hybrid terrestrial and underground wireless sensor network ► Develop a test model about WUSN ► Path loss and bit error rate under different operating frequencies and water contents ► The relationship between path loss of transmission and node buried depth.

Keywords

Hybrid wireless sensor network; Information collection; Agriculture; Wireless underground sensor network; Monitoring

https://www.sciencedirect.com/science/article/abs/pii/S0920548912000608

Wi-Fi Based Smart Wireless Sensor Network for an Agricultural Environment

Authors: Gerard Rudolph Mendez, Subhas Chandra Mukhopadhyay

Abstract

Environmental Monitoring Systems and Sensors systems have increased in importance over the years. However, increases in measurement points mean increases in installation and maintenance cost. Not to mention, the measurement points once they have been built and installed, can be tedious to relocate in the future. Surely, with the technology of today, there is a better way to overcome this problem. The chapter will present the development work of a Wi-Fi based Smart Wireless Sensor Network for monitoring an Agricultural Environment. The system is capable of intelligently monitoring agricultural conditions in a pre-programmed manner. The system consists of three stations: Sensor Node, Router, and Server. The system is designed for monitoring of the climate condition in an agricultural environment such as field or greenhouse, the sensor station is equipped with several sensor elements such as Temperature, humidity, light, air pressure, soil moisture and water level. In addition investigation was performed in order to integrate a novel planar electromagnetic sensor for nitrate detection. The communication between the sensor node and the server is achieved via 802.11g wireless modules.

Keywords
Sensor Node; Wireless Sensor Network; Short Message Service; Network Address Translation; Agricultural Environment

Introduction

Agriculture has been around for thousands of years [1] allowing civilisations to expand by breaking away from nomadic lifestyles and building permanent settlements. It has an integral place in our current civilization and agricultural practices such as irrigation, fertilizers and use of greenhouses are wide spread. Agriculture is often characterized by enhanced productivity, and sometimes the reduction of human labour required. Agricultural products are dependent upon environmental factors where plant growth and development are largely affected by the conditions experienced. Similarly diseases that occur due to environmental factors can cause plant growth to be significantly affected. To deal with environmental factors such as cold, wind and excessive sun new practices were implemented. For example, in the 13th [2], 18th and 19th centuries [3] glasshouses, or greenhouses were developed; these allowed for the protection and cultivation of exotic plants imported to Europe that were acquired during travel expeditions. Since the European colonisation of New Zealand, it has grown to become a largely agricultural dependent country. The environment in New Zealand allows for a wide variety of products. Kiwifruit, avocados, feijoas, peaches, plums, cherries, berries and more can be grown here. Agricultural environments such as fields and greenhouses allow growers to produce plants with an emphasis on agricultural yield and productivity. In addition, it also provides the possibility to grow plants in environments previously not suited for the task. In particular, the use of greenhouses provides plants with protection from harsh weather conditions, diseases and a controlled environment. An emphasis on agricultural yields however should be balanced with use of resources and sustainability [1][4]. This can only be done based on a deeper understanding and/or monitoring of the environmental systems. In particular the ongoing discussion will likely continue surrounding the potential for sustainable agriculture.

https://link.springer.com/chapter/10.1007/978-3-642-36365-8_10