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Applications of Wireless Sensor Networks in Food and Agriculture Sectors

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***Abstract*-This paper presents an overview on current progress of wireless sensor technologies and standards for wireless communications as applied to wireless sensors. Examples of sensor networks and wireless sensors applied in agriculture and, precision agriculture. The paper also converse compensation of wireless sensors and obstacles that prevent their fast approval. Lastly, based on an analysis of market expansion. , the paper conversed prospect trend of wireless sensor technology development in agriculture.**

***Index Terms*-** Wireless Sensor Networks, Agriculture, Sensor Node, M2M Communication

I. INTRODUCTION

During the recent year the Wireless technologies have been developed rapidly. There are various types of wireless technologies which has been developed range from simple IrDA to WPAN and WLAN. the simple IrDA uses IR light for short-range, point-to-point communications while WPAN (wireless personal area network) for short range, point-to multi-point communications e.g Bluetooth and ZigBee, the WLAN is the mid-range, multi-hop wireless local area network, to long-distance cellular phone systems, like CDMA and GPRS/ GSM.

Due to the amazing growth of cell-phone in market most of the people are attracted toward wireless technology. Some of the people has appreciated the claim interpersonal communications and bandwidth for wireless such as cellular phone. At the end of the decade only 3% people will share the total available bandwidth [1]. For the development and applications of the various type of wireless technologies huge prospective is be present, particularly sensor networks and wireless sensors, initially from environmental monitoring and military affecting towards machine-to-machine communications (M2M), and finally getting all aspects of our lives.

A wireless sensor network (WSN) system consist sensors, radio frequency (RF) transceivers, power sources and microcontrollers. Due to self-diagnosing , self-organizing, self-healing capabilities and self-configuring Wireless sensor networks can solve problems. Once presented, these technologies would permit us to find many new applications that could not have been supposed possible before.But still the Wireless sensor technology is in early development stage. in food industry and agriculture the wireless sensors has limited applications. The following are the available wireless sensors technologies that are to agriculture and food industry.

II. USE OF WSN

The wireless sensor nodes are used because it has a significant reduction and simplification in harness and wiring. It has been estimated that wireless technology eliminate 20–80% of the total cost e.g , Honeywell installed a wireless system to monitor steam traps and saved the company US$ 100,000–300,000 per year [2].

The MEMS sensors is permitted by Wireless sensor technology to form motes by integrated radio units and signal-conditioning with small size, low power requirement and extremely low cost. MEMS inertial sensors, temperature sensors, strain-gage sensors, pressure sensors, humidity sensors and various piezo and capacitive sensors for proximity, acceleration, position, vibration and velocity measurement been included to wireless sensor nodes and have develop into on hand on the market [3].

Wireless technology decrease difficulty maintenance and costs. Wireless sensor networks permit more rapidly the installation and deployment of various types of sensors various of these self-configuring, self-diagnosing, provide self-organizing and self-healing capabilities to the sensor nodes.

III. Software and Hardware Requirements for Wireless Sensor Motes

Following are the hardware and software requirements for wireless sensors and "motes. The following Software required for wireless sensors

a. High modularity
b. Capability of fine grained concurrency
c. Efficient energy use
d. Small footprint to run on small processors,
e. Robust ad hoc mesh networking that requires low power.

The following hardware components are required for wireless sensors

a. Long-lifetime energy source
b. Low cost
c. Energy-efficient processor
d. Robust radio technology
e. Flexible I/O for various sensors
f. Flexible, open source development platform [5].

In wireless sensor network, node is produced by a sensor/data acquisition board and a mote (processor/radio board). These nodes have capacity of communicating with other computer via other networks like WPAN, LAN, WLAN and the Internet. the available Wireless sensor are barometric pressure sensors, GPS modules, accelerometers, humidity sensors, GPS modules, temperature sensor,s magnetometers, acoustic sensors, pyroelectric IR occupancy detectors, soil moisture sensors, magnetic RPM sensors, seismic sensors, wind speed sensors and rainfall meters

IV. Wireless standards

A wide range of wireless standards have been reputable. Among them, the standards for wireless PAN, IEEE 802.15.1 (Bluetooth) (IEEE, 2002) wireless LAN, IEEE 802.11b ("WiFi") (IEEE, 1999b) and IEEE 802.15.4 (ZigBee) (IEEE, 2003) are used more extensively for automation and measurement applications.

These standard deals with the network problems for wireless sensors. The following three type of network are developed and standardized.

1. Star network (used by Bluetooth technology)
2. Hybrid network (used by ZigBee technology)
3. Mesh network (allow autonomous nodes to self-assemble into the network) [6].

V. Agricultural Applications

The use of sensor networks and wireless sensors in agriculture is still at the beginning stage. The Applications of sensor networks and wireless sensors can be classified into the following groups:

1. Environmental monitoring
2. Precision agriculture

1. Environmental monitoring

In Canada, Sixty-five nodes were installed in a 1-acre land to report light intensity, temperature, and moisture to a central PC every 5 min. so in this way the possessor can easily manage each area avoid determine fertilizer applications, frost, manage irrigation and arrange harvest schedule. Solar-

powered wireless sensor network to give weather information in fields. A remote application server transmits data from the sensor network to local consumer through a WLAN and remote consumer through cellular network and the Internet [8].

2. Precision agriculture

The Wireless sensors are used in precision agriculture to help in (A) spatial data collection, (B) variable-rate technology and (C) supplying data to farmers.

A. Spatial data collection

Authors in [9] developed a mobile field data achievement system to save data for spatial-variability studies and crop management. The system was capable to carry out local field survey and to collect data of soil water availability, biomass yield, soil fertility, leaf chlorophyll content, local climate data, leaf area index, leaf temperature, soil compaction, grain yield, insect-disease-weed infestation, plant water status etc. A silage yield mapping system was developed by [10] which contain a moisture sensor, load cells, a GPS and a Bluetooth wireless communication module. The Bluetooth transmitter and moisture sensor were installed on the chopper. The moisture sensor sends signals to Bluetooth receiver on a host PC at a rate of 115 kbps and was used to correct the yield data.

B. Variable-rate technology

An automated fertilizer applicator is developed for tree crop. In this system GPS and real-time data acquisition is performed by input module , how to calculate the optimal quantity and spread pattern for fertilizers is done by decision module and to calculate the fertilizer application rate is done by the output module . Hence, Bluetooth network is being used for the data communication among the modules [11].

C. Supplying data to the farmers

Authors in [12]developed a web server in which information about pest, disease infestation and weather forecasts have been provided. Information can be directly downloaded via internet by the farmers and then used that information for the operation scheduling.

A research has been conducted in Mississippi by USDA for developing such a high-speed networking system which would be helpful for the farmer to download images into their PCs or laptops by using WLAN.

3. Precision irrigation

A tested remotely controlled, automatic irrigation system to control a 1500 ha irrigated area in Spain were developed byDamas et al. (2001). the area divided into seven region and each region was controlled and monitored by a control sector. each sectors communicated to each other and with a central control via a WLAN network. The Field tests demonstrate 30–60% saving in water usage.

VI. Trends of Wireless sensors in future

In the earlier period, it was believed that the use of excessive wiring in motor vehicle is a sign of technological improvement. In 1955 the 45 m electrical wires were used in automobile but this no of electrical wires were increased upto 4 km in 2002. while the number of electrical wire in mobile vehicles is greatly decreased [13-21], but still the modern vehicles strongly attached to "steer-by-wire", "wire", "throttle-by-wire", "break-by-wire" and", "suspension-by-wire". Ii is unsafe and unreliable by replacing "X-by-wire" with "X-by-wireless". The M2M revolution replaces wired with wireless controls [22-46]. At the end of decade, the auto industry will finally start approving wireless technologies.

VII. Conclusion

In effect the main tool for agricultural operations is Large-power and heavy weight farm machines. These machines create some serious problems like it cause permanent damage to fields, consume an huge amount of fuel, and their large size prevents "farming by foot" and "farming by plant". Small robots can replace large machine if the robots is programmed it will perform different function in crop fields as well as in forestry, plantations and orchards. Computer-controlled robots and Wireless sensors are a

wonderful arrangement to well in this trend. Wireless sensors and sensor networks have just entered farms and food plants. They will have a bright future.

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