The Design and Manufacture of a Sample of Wireless Sensor's Networks in the Field of Agriculture

Amin Reza Jamshidi and Ali Afrous

Department of Engineering, Andimeshk Branch, Islamic Azad University, Andimeshk, Iran

ABSTRACT

Any agricultural operation is conducted in accordance with the conditions prevailing in the agricultural environment. So, the accuracy in estimating environmental conditions increases efficiency. These various time and place circumstances are different. As a result, agricultural operation should be done in accordance with conditions of different area of farm in any time. Through increasing in accuracy in point-to-point measurement, the efficiency will be increased. To achieve the above objectives, some tools called sensors, are used which by the use of them, different environmental parameters are measured. These sensors have been installed in some nodes which take the responsibility of transmitting incoming data to main center for storing data and required reactions in specific conditions. These nodes form a wireless network of sensors which can be distributed widely on the farm to receive required information by using embedded sensors on them. This article introduces a node of this network and applied sensor’s range and duties of each sensor in helping the agriculture will be mentioned. The designed circuit of node includes thermal humidity and optical sensor which they transmit incoming data to another node through wireless communication. The applied senders and receivers in circuit design work at a frequency of 915 MHz. The Applied central processor in node is also a microcontroller AVR which all the processing and monitoring operations are performed by them.

INTRODUCTION

Increasing development of computer networks and the need for access to more information and resources without physical and hardware access has led to development of wireless and mobile application and now we can transmit our data and information to considered destination in whole the world without having physical wired connection. The application of wireless networks technology beside embedded system led to advent of micromechanical system technology in which microprocessors, sensors and telecommunication circuits have been placed in a system and they pursue one goal together and by the use of some of these system together, a network has been achieved which is the solution of many everyday and necessary needs. These system are named sensor’s networks and because have been formed contingency and wireless, they are called contingency (hoc) wireless sensor’s networks. Low consumption, low cost, small size and distributed pieces in wireless sensor’s nodes have caused that the local processing, wireless communication, collecting and distributing information in wireless sensor’s networks takes place easily and it is possible to be easily aware of information regarding place which there is no access to it. Each sensor’s node has the limited processing capabilities, but it can process detailed information if it be placed in a network with other sensor’s nodes and it can offer perfect information to user. Note to these networks application in the field of agriculture will be a worthy help to achieve precision farming and appropriate application of resources. As an example, we can refer to the usage of wireless sensor’s networks in farms and greenhouses. The accurate measurement of temperature, light and other cases according to special conditions of environment which has been under study, are the capabilities of these kinds of networks which due to enjoyment of wireless connection, the usage of these kinds of networks will be more economic, easy and sufficiency compared with other methods. The method of manufacturing wireless...
sensor’s nodes in order to be used in greenhouses and farms will be completely explained later. The sensors convert the physical and chemical parameters changes to electronic parameters changes.

The general diagram of electronic measurement tools has been offered in figure 1. Because electronic circuits have many efficiencies such as flexibility, high speed, accuracy, the ability to be analyzed, the possibility to processing and recording information, they are used in agriculture and generally in accurate system. The sensors work by seven form of resistive, inductive, capacitive, piezo electronics, photo electronic, elastic and thermal. The factors which play role in selecting an sensor included: linear or non-linear output changes of sensor toward environmental parameters change, accuracy, useful life, response time, the method of work, the amount of required energy for creating appropriate changes in sensor’s output, cost and rate of changes.

![General diagram of electronic measurement tools](image1)

**Fig. 1:** General diagram of electronic measurement tools.

The sensors are generally used in agriculture for below purposes:
1. Feel the properties of soil: texture, structure and physical state of soil, The moisture and food
2. Feel the plant: the population of plant, tension and nutritional status of plant
3. The monitoring systems on product: the plant product, the moisture of product, reaping the width of implant row
4. The systems with variable rate technology
5. The monitoring of climate parameters: temperature, humidity, the wind speed, wind direction, lighting

**The material and methods:**

The wireless sensor’s node constitutes of the below main parts which the correct selection of each one of parts will be important in its different designing according to the kind of application. These components as they observed in Figure 2 including: power supply, processing unit, and sensor unit, transmit unit. One of the issue that is important to observe in designing the most of wireless sensor’s nodes are the small size and low power consumption. For providing the first case, it is required to be accurate in preparing the components which are as small as possible in size with the same capabilities, in second case, applied power supply and how to apply it play a worthy role in reducing power consumption.

![Including: power supply, processing unit, and sensor unit, transmit unit.](image2)

**Fig. 2:** Including: power supply, processing unit, and sensor unit, transmit unit.

**Hardware components of designed node:**

**Central controller:**

In this part, microcontroller AVR in model Atmega16 has been used. These 8 bite microcontrollers have been considered because of the programming capability by high level language compiler. These microcontrollers enjoy architecture and they use CMOS technology in manufacturing pieces. The ATMEAL Company has aimed to decrease the volume of manufactured code and increase the speed of program implementation by the use of advanced architecture and optimal instructions. One of the characteristic of this microcontroller is that it enjoys 32 number of general-purpose register. Also in this microcontroller, low consumption and nonvolatile memories are used. The other capacity of these microcontrollers are execution of
the instruction in a processor cycle and supporting many communicative standards such as JTAG, UART 12C and SPI which can connect these microcontrollers to other microcontroller or other device and establish communication with them easily.

**Thermal sensor DS18B20:**

The applied sensor in this plan is the node in model DS18B20 and in the kind of integrated circuit sensors and it is a semiconductor thermostat which has been popular nowadays, because they can be used in standard chips. The temperate-dependent oscillators are used in these kind of sensors. Therefore, a simple counting is enough to measure temperate. These kind of sensors are cheap and accessible nowadays. The measurable temperate by DS18B20 is from -55 C up to +125 C which the sensor’s sensitivity is +0.5 from the temperature -10 C until +85 and in this output, the sensor’s response is almost linear. (It is 0.0625 C in 12 bite and 0.05 C in 9 bite). The response time of the sensor is up to 0.05 C which consists of calculating temperate and converting it to 12 bite digital-word. The method of connecting sensor is so that it works in positive mode and it does not need to a separate power supply. In this way, the power consumption is increased and through that line, the sensor data is provided.

**Humidity sensor:**

This sensor is actually a sensitive capacitor to moisture and it has not output singly, but there should be created a circuit for it and some ideal changes should be created through capacitor’s changes. The method of measuring moisture of whether or soil by the use of sensor is through frequency measurement. It means that resistance changes or sensor’s capacity has been led to frequency’s changes and environmental parameters can be obtained through frequency measurement and evaluating received data. Therefore, an AC 555 has been used for it. The method of using this IC is seen in figure 3.

**Light sensor (Flame):**

This kind of sensors are divided to two general categories including photovoltaic and photoconductive. The photovoltaic sensors are built by semiconductor pn. Their problem is their non-linear changes. The photoconductive sensor can be divided to three categories including photodiode, photo transitive and LDR (dependent to light). One of the benefits of LDR is its sensitive conformity with eyes’ sensitive wavelength. But more appropriate sensor for estimating the level of photosynthetic activity of plant, is Quantum sensor. These sensors measure the amount of photons hit the surface which is an appropriate method to measure the energy which have been received to plant in the area of effective radiation in photosynthetic.

The applied sensor in this plan has been LDR which is a kind of sensitive resistance to light and its resistance will be decreased in the light and it will be increased by light reduction.

The introduced sensors can help to prevent the occurrence of some events such as forest fires or it can be used as better as possible to protect farms and greenhouses.

**Wireless sender and receiver:**

The sender and receiver HM-t and HM-r are considered as radio waves’ sender and receiver which enjoy the technology FSK and it is an appropriate superseded for the senders and receivers which were used technology FSK. The clear characteristic of this module is: technology FSK, suitable for replacement with ASK technology, the application of the band ISM, 915 MHz, the very small size, low interference, high sensitivity and low consumption. This module has used the serial communication protocol and it connects to RX and TX microcontroller bases, and consequently the rate of data forwarding is limited.

If data base remain workless for the time more than 70 ms, this module enter automatically to standby and thus, its power consumption will be decreased and it can be controlled.

**Design of wireless sensor’s network:**

Sensor’s nodes are scattered in an area and the method of their sort and relationship in environment determine the kind of our network’s design. Each node is capable to receive and send the information. It also can collect the information and transmit it to sink. Sink node is responsible for receiving information from nodes in order to if it is necessary, it transmits received data to other centers or itself process the information and apply required information (Figure 4).

A simple method has been used to prevent the interference in using shared communication channel.

In this manner that, for example node D for sending start, transmit SYNC signal for node E and node E is awaiting for response in this state and it does not send any data until the signal relates to sending end, receive data from node D. Then node E for sending start sends the required signal to node D and then transmit considered data and so on, the sending and receiving will be continued. If the number of nodes increase, similarly, each node can inform other nodes through sending its start signal and other nodes do not send any
thing. This sink node will be informed through receiving each node’s start signal that following transmitted data are related to each node and then receive it.

Conclusion and discussion:

According to increasing application of wireless sensor’s network in places whose access is difficult, and these networks’ effective role in processing and collecting data, nowadays how to design and manufacture the sensor’s nodes which have basic role in these networks, it is particularly important.

The purpose of this article is to present a simple design by using available accessories and not too expensive and by required capability and appropriate power of consumption. This wireless sensor’s node has been designed so that it can be used in the farms, greenhouses, aero logy and other environmental applications and then a simple network of sensors will be implemented by using them.

REFERENCES