Sensor and arduino based monitoring system in Albanian agricultural domain

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Abstract

This paper proposes a real-time system based on sensors and Arduino for monitoring the temperature and humidity of the environment. Instead of measuring manually these parameters in different times during the day, the proposed system will measure them in real time and show the results to the users. The system is composed of sensor network build with Arduino to measure the parameters and the web application which will be used to present the result to the users. It will register the data in specific intervals in the database. These data will serve as historical data and can be shown to the users in graphical form through the web application. The web application will be used to provide to the farmers useful data about the environmental parameters in order to prevent hazardous incidents. The collected data can be analyzed and extract useful information that can be used to develop recommendation in the future.

1 Introduction

Agriculture domain is very important in Albania not only for the production of food but also for supporting a large scale of employment. According to the Agricultural census conducted in 2012 in Albania there were 324,000 farms in Albania and number of employed in agriculture, forestry and fisheries was 51% of the total. This sector has been steadily growing reaching an annual growth. ICT has big impact on agriculture providing opportunities for farmers [AS13]. Precision Agriculture (PA) is an agricultural system information-based and technology-driven designed to improve the agricultural practices and processes in order to maximize the productivity of farms[KMH14].

Agricultural activities are affected by environmental factors such as ambient temperature and humidity. Therefore, it is important to monitor environmental parameters and make effective use of the resources through the design and implementation of systems which can monitor these parameters [Chun13].

In this paper, we present a real time agricultural environmental monitoring system using wireless sensor networks based on arduino, capable of measuring temperature and humidity. The web application module of the proposed system will act as the farmer's assistant in the field. It will provide essential agriculture related information like temperatures environment and humidity to the farmer. The database of the system will keep track of the data related to the environmental information as well as the data related to the inventories of the farmer, purchases or equipment. The organization of this work is as follows. Section 2 contains the related work, in section 3 the design of the proposed system is presented, and section 4 and 5 provide details about hardware components and software implementation of the proposed system. Finally conclusion and future work has been discussed in the section 6.

2 Related Work

Several solutions are presented in the literature using network of sensors in the agriculture domain. Sensor wireless network are becoming an ideal, effective and economical solution for monitoring issues because it is feasible to install wireless access points at locations where cabling is almost impossible, and it also reduces infrastructure costs [AS13]. In [APY+15] an implementation of a wireless sensor network for monitoring of environmental parameters using sensors, an Arduino microcontroller and GSM module for transmitting the data to the Receiver station through

SMS is presented. A distributed Monitoring Systems comprised of a self-organizing wireless sensor network, a GPRS Gateway which gathers data and provides a TCP-IP based connection toward a Remote Server and a web application which manages information and makes the final user capable of monitoring and interacting with the instrumented environment are explained in [PBC+10]. The web and android platform is used to show the measurement results from ZigBee sensors for monitoring the environment parameters such as temperature, humidity and air quality in a factory [LHS13]. The research proposes to use ZigBee, Wi-Fi protocol and integrated embedded system built by the open-source 32-bit ARM (Advanced RISC Machine) core Arduino Due module. The potential of arduino is used in thousand of projects ranging from simple to very complex systems in different domains. Arduino as an inexpensive microcontroller platform offers many advantages to its users such as simple programming environment, open source and extensible software and harware. The proposed system is based on arduino technology to benefit from its advantages.

3 The proposed system

The environmental monitoring system is based on a wireless sensor network. It consists of the sensor nodes for measuring temperature and humidity, Arduino coordinator node for local computation, Wifly module for data communication and web application for displaying the parameters to the user.

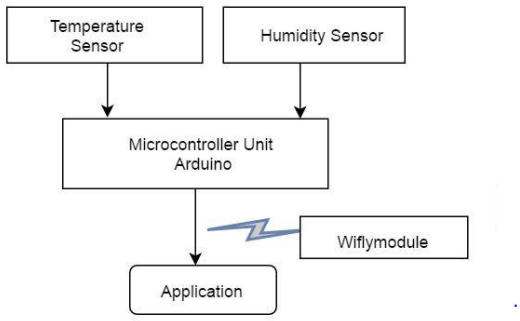

Figure 1: Diagram of the proposed system

The Wifly Shield is used to establish communication between the microcontroller and the web application.

4 Hardware Implementation

Temperature and humidity parameters are measured by the sensor DHT11. DHT11 is multifaceted with a calibrated digital signal output features. The DHT sensors are made of two parts, a capacitive humidity sensor and a thermistor. A basic chip inside does analog to digital conversion.

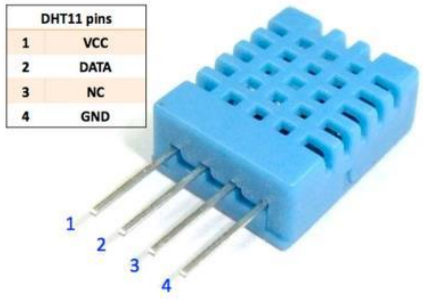

Figure 2: DHT11 Sensor

DHT11 module works on serial communication. This module sends data in specific time period to Arduino. The specific characteristics of this sensor are:

- The function tension is 5 v
- Measure the temperatures in the range from 0-50°C with accuracy ±2°C
- Measure the humidity in the range 20-90% with accuracy ±5%
- No more than 1 Hz sampling rate (once every second)
- Body size 30mm x 20mm

Arduino Uno micro-controller (ATMEGA328) is the main component that is connected to all the components. It's an open-source physical computing platform based on a simple micro-controller board, and a development environment for writing software for the board[KTKP15]. Arduino projects can be stand-alone,

or they can communicate with software running on your computer.
Its technical characteristics that make it very suitable to suport the micro-controller, connect it to a computer, power it with an AC-to-DC adapter or battery to get started are :

- The function tension is 5 v
- Input tension is 7-12 V
- 14 digital input/output pins
- 6 analog inputs
- 16MHz ceramic resonator
- USB connection
- Power jack
- ICSP header
- A reset button
- Frequency 16 MHZ
- flash memory 32 KB
- memoria SRAM 2KB
- EEPROM memory 1KB

The image of Arduino Uno is dipslayed in the figure 3.

Figure 3: Arduino Uno

WIFI which is known as IEEE 802.11x is the most known technology for wireless connection of computers or smartphones. Arduino utilizes the WiFI shields to allow the microcontroller to function with greater mobility. Shields are special boards you can purchase that support a specific function. Through WiFI Shields signals are transmitted over an 802.11x.

Figure 4: Wifly shield

Depending on the protocol used, WiFi 802.11x is capable of receiving signals in a frequency range of 2.4 – 4GHz, and with data rates ranging from 1- 150 Mbit/s [IEEE08]. Different equipment offer different transfer rate until 54 Mbps and distance 150 meters with frequency 5 GHz. The connection of arduino to the wireless network is done through Wifly module RN-171. The module is pre-loaded with firmware to simplify integration and minimize development time of the application. An on-board antenna allows the shield to cover a wider range and transmit stronger signals. The RN-171 module supports TCP, UDP, FTP, and HTTP communication protocols to meet the needs of wireless network.
In figure 5 our respective design of the hardware components using Fritzing environment is presented. Fritzing is an open source tool for anyone to teach, share, and prototype their electronic projects.

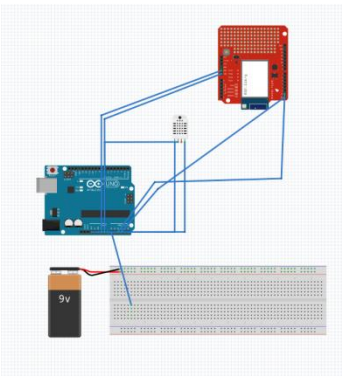

Figure 5: Hardware design

A screenshot from the real system is shown in figure 6.

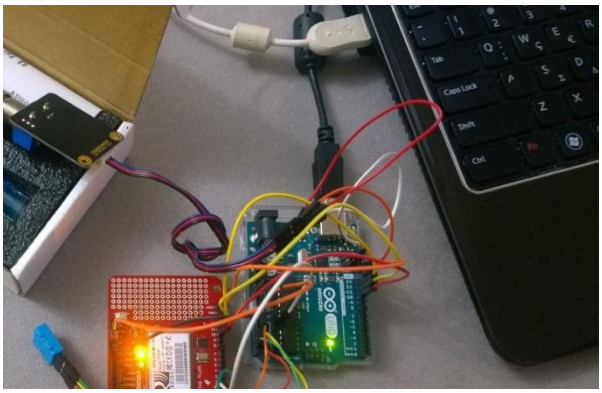

Figure 6: The hardware composition

5 Software implementation

The following technologies CSS, HTML5, Bootstrap, XAMPP, MYSQL, PHP and an ecommerce template were used to design the site and its implementation. The web site will connect to arduino to get the measurements from the sensors. Steps and installation are shown as follows:

- Installation of XAMPP.
- Installation of the template in XAMPP.
- Building of the database.
- Constructing and applying the harduino sketch to arduino
- Configuring arduino with the sensors. Uploading the arduino, wifly shield and sensor DHT11 libraries.Using the WiFLYHQ library to set up and menage WIFly module.
- The web application will be able to answer a HTTP request through the wifly shield and display the results in the web page.

In the figure 7 a screenshot of the measurements graphic is displayed.

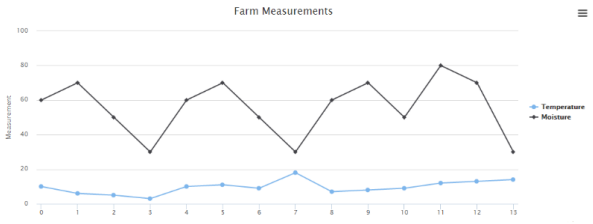

Figure 7: The graphic of the measured parameters

6 Conclusions and future work

This paper deals with the design and development of a system which uses a wireless sensor network based on arduino to measure and monitor the parameters needed in agricultural domain. Every constitutive element of the system was described in detail in order to point out the features and the advantages. The proposed system benefits from the open nature of the arduino technology and wifi. This system is designed in such a manner that it can be extended in the future in two directions: adding more sensors in the wireless sensor network such as sensor for the measurement of the PH parameter and extending the web site to infom the clients about the products and to sell the products.
Once this system is fully implemented we will come up with an independent low cost system which will measure elements such as the temperature and humidity as well as it will provide products data in real time on a site which has two functions at the same time: to inform the customer and the farmer.

It would be of special assistance even to the consumer in Albania when the food safety and informing on national products are concerned.

It is a system which complies with the farmers as well as the consumer in Albania. We believe that this project can further be improved and enriched in order to be installed in big agricultural farms.

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