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Design of Greenhouse Monitoring Using Sensor Network based on Ardunio

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Abstract: The main aim of this project is to monitor the basic parameters of the green house. Different sensors are used in this project to measure various parameters. Temperature sensor will be used to get the temperature, fire occurrence also measured by using fire sensor. LCD will display the current Fire sensor, temperature sensor (LM35), gas sensor (MQ-2) and PIR sensor values. To display the Fire sensor, temperature sensor (LM35), gas sensor (MQ-2) and PIR sensor values initially these values have to be converted into digital values. ADC is used to convert the analog parameters into digital values. Thus, whenever the Fire sensor, temperature sensor (LM35), gas sensor (MQ-2) and PIR sensor values exceeds the set point, the LED lighting system will be turned on automatically. Voice module will be also used in our project to indicate the danger situation of all sensor values. Those sensor values cross the threshold level then automatically that information will be passed to the user mobile.

Keywords: Greenhouse Monitor, PIR Sensor, Fire Sensor, Gas Sensor (MQ-2).

INTRODUCTION

A greenhouse is a building in which plants are grown for commercial or research purposes. These structures range in size from small sheds to very large buildings, with different types of covering materials, such as a glass or plastic roof and frequently glass or plastic walls; it heats up because incoming visible solar radiation (for which the glass is transparent) from the sun is absorbed by plants, soil, and other things inside the building. Air warmed by the heat from hot interior surfaces is retained in the building by the roof and wall. In addition, the warmed structures and plants inside the greenhouse re-radiate some of their thermal energy in the infrared spectrum, to which glass is partly opaque, so some of this energy is also trapped inside the glasshouse. However, this latter process is a minor player compared with the former (convective) process. Thus, the primary heating mechanism of a greenhouse is convection. Ventilation is one of the most important components in a successful greenhouse. If there is no proper ventilation, greenhouses and their plants can become prone to problems (Zagade, Kawitkar, 2012). The main purposes of ventilation are to regulate the temperature to the optimal level, and to ensure movement of air and thus prevent build-up of plant pathogens (such as Botrytis cinerea) that prefer still air conditions. Ventilation also ensures a supply of fresh air for photosynthesis and plant respiration, and may enable important pollinators to access the greenhouse crop. Ventilation can be achieved via use of vents - often controlled automatically - and recirculation fans.

Embedded greenhouse monitoring and control is proposed to provide a highly detailed micro-climate data for plants within a greenhouse environment with an innovative method of growing temperate crops in a tropical environment using microclimatic conditions. The greenhouse was equipped with conventional wired sensors that provide readings of the air temperature, light intensity, soil moisture in the mixing tank and fire. The acidity and concentration of the nutrient solution were manually measured, and adjusted accordingly, and high resolution data, collected with the deployment of a network of wireless sensors to provide sufficient data to develop a model for the growth of these crops under aeroponic conditions (Leong et al., 2009).

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The proposed system is an embedded system which will monitor the microclimatic parameters of a greenhouse on a regular basis round the clock for cultivation of crops or specific plant species which could maximize their production over the whole crop growth season and to eliminate the difficulties involved in the system by reducing human intervention to the best possible extent using sensors, Analog to Digital Converter, microcontroller and actuators (Stipanicev, Marasovic 2003).When any of the above mentioned climatic parameters cross a safety threshold which has to be maintained to protect the crops, the sensors sense the change and the microcontroller reads this from the data at its input ports after being converted to a digital form by the ADC (Leong et al., 2009). The microcontroller then performs the needed actions by employing Bluetooth module until the strayed-out parameter has been brought back to its optimum level. Since a microcontroller is used as the heart of the system, it makes the set-up low-cost and effective nevertheless. As the system also employs an LCD display for continuously alerting the user about the condition inside the greenhouse, the entire set-up becomes user friendly. Thus, this system eliminates the drawbacks of the existing set-ups and is designed as an easy to maintain, flexible and low cost solution.

Block Diagram of the Project and its Description

The block diagram of the design is as shown in Fig. 1. It consists of power supply unit, microcontroller, GSM, fire sensor, temperature sensor (LM35), gas sensor (MQ-2) and PIR sensor, and LCD. The brief description of each unit is explained as follows.

Block Diagram

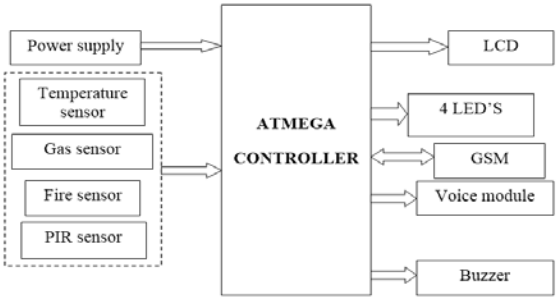


Fig. 1: Block diagram

Working Procedure

The main aim of this project is to monitor the sensor values and get the notification from the GSM modem to your mobile whenever any one of the sensors activated. The corresponding LEDs will be ON and gives alert by voice for respective sensor detection.

The sensors we used in this project are fire sensor, temperature sensor (LM35), gas sensor (MQ-2) and PIR sensor. Fire and gas sensors will detect the over temperature and the fire accidents respectively. The gas sensor will detect the gas leakages and the PIR sensor detects the persons moment. All these sensors are connected to the ARDUINO UNO microcontroller. Fire, temperature, and gas sensors are connected to the internal ADC of the ARDUINO UNO. We are setting some threshold digital values for each of the Sensors to detect the activation of the sensors. If any of these sensors activates, the ARDUINO UNO microcontroller will sent the corresponding message to the pre-defined numbers. Initially we are storing pre-defined mobile numbers, to which you want the reply message by sending an empty message to the GSM modem. Besides that message we ON the respective LED for each sensor detection and giving the voice alert. Initially we are storing the voices for each sensor in the voice IC apr33a3. Whenever one of the sensors detects, the corresponding voice will come out from the speaker. The code was written in embedded C language and compiled using ARDUINO compiler to generate the hex file. The generated hex file was downloaded into the ARDUINO UNO microcontroller.

ARDUINO MICROCONTROLLER

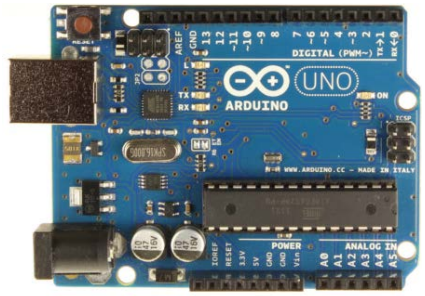
The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB to- serial converter.

Revision 3 of the board has the following new features:

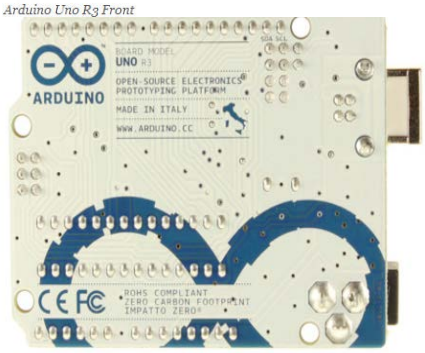
- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous version.

Ardunio Board



Arduino Uno R3 Front



Arduino Uno R3 Back

ATmega328P-PU with Arduino Bootloader

Programming

The Arduino Uno can be programmed with the Arduino software.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C headerfiles).

You can also bypass the bootloader and program the microcontroller through the ICSP (In- Circuit Serial Programming) header; see these instructions for details. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.
- You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of theATmega8U2/16U2 is connected to the reset line of the

ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Temperature Sensor

LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated.

The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1/4°C at room temperature and ±3/4°C over a full −55 to +150°C temperature range. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air.

THERMISTOR (FIRE SENSOR)

A **thermistor** is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting over current protectors, and self-regulating heating elements.

Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range, typically −90 °C to 130 °C.

GAS SENSOR OR SMOKE SENSOR

Electrochemical gas sensors are gas detectors that measure the concentration of a target gas by oxidizing or reducing the target gas at an electrode and measuring the resulting current.

(or)

Testing the Sensor

Measure the output voltage through multi-meter between A.OUT and Ground pins or Use a microcontroller to measure the voltage output. Take the sensor near combustible gas place like cooking gas stove with flame off or near bottle of after shave liquid or cigarette light with flame off. You will notice sudden jump in analog voltage output since the gas concentration will increase.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

GSM TECHNOLOGY

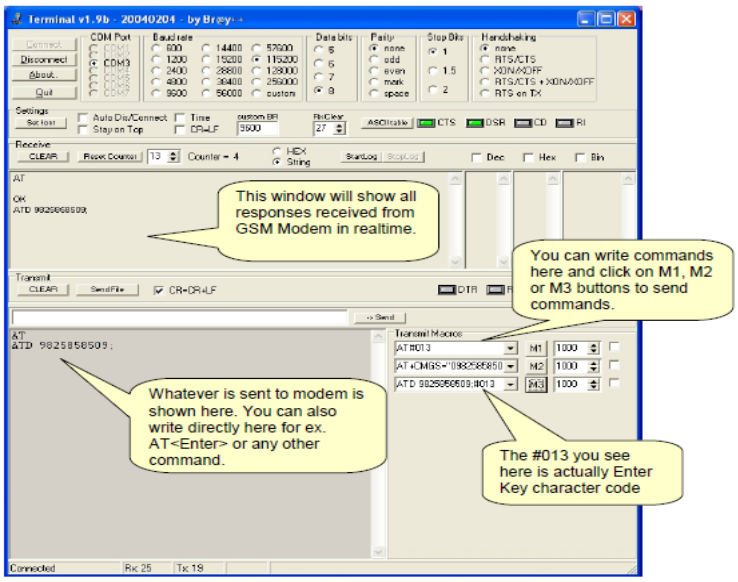
GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA).

GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

Using GSM Modem with PC

If you wish to use GSM modem with PC then connect serial cable to PC and power it on. Use the supplied serial cable to connect to PC's serial port. Use Hyperterminal software which comes with Windows XP or use any other Terminal software with following settings.



Sample Code for Interfacing with microcontroller for sending SMS

If you wish to use GSM modem with PC then connect serial cable to PC and power it on. Use the supplied serial cable to connect to PC's serial port. Use Hyperterminal software which comes with Windows XP or use any other Terminal software with following settings.

Interfacing MAX232 with Controller

Connect MCU TXD/RXD through MAX232 so your MCU can communicate with GSM Modem.

Firmware Implementation

This chapter briefly explains about the firmware implementation of the project. The required software tools are discussed in section 4.2.

Software Tool Required

Arduino 1.0.6 software tools used to program microcontroller. The working of software tool is explained below in detail.

Programming Microcontroller

A compiler for a high level language helps to reduce production time. To program the Arduino UNO microcontroller the Arduino is used. The programming is done strictly in the embedded C language. Arduinois a suite of executable, open source software development tools for the microcontrollers hosted on the Windows platform. Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

One of the difficulties of programming microcontrollers is the limited amount of resources the programmer has to deal with. In personal computers resources such as RAM and processing speed are basically limitless when compared to microcontrollers. In contrast, the code on microcontrollers should be as low on resources as possible

CONCLUSION

A step-by-step approach in designing the microcontroller based system for measurement and control of the four essential parameters for plant growth, i.e. temperature, fire, gas, and PIR has been followed. The results obtained from the measurement have shown that the system performance is quite reliable and accurate. The system has successfully overcome quite a few shortcomings of the existing systems by reducing the power consumption, maintenance and complexity, at the same time providing a flexible and precise form of maintaining the environment.

The continuously decreasing costs of hardware and software, the wider acceptance of electronic systems in agriculture, and an emerging agricultural control system industry in several areas of agricultural production, will result in reliable control systems that will address several aspects of quality and quantity of production.

Further improvements will be made as less expensive and more reliable sensors are developed for use in agricultural production. Although the enhancements mentioned in the previous chapter may seem far in the future, the required technology and components are available, many such systems have been independently developed, or are at least tested at a prototype level. Also, integration of all these technologies is not a daunting task and can be successfully carried out.

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