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RESEARCH ARTICLE

Design and Implementation a Smart Greenhouse

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Abstract

In recent days; the controlling systems are adapting and implementing irrigation in order to meet people requirement. The main reason behind this deficiency is that estimating required irrigation amount is a complex process and need consideration of several significant factors. This paper proposes an efficient automatic irrigation system based on computing various changes necessary in green house using wireless sensor network and using server and client web service for control and monitoring. Our model has two main factors which are reduces the power and controlling and monitoring over long distances. The results demonstrate that the control model is measure the sensing data and accurate tool for calculating values of adapted sensors as well as the self-control the output plugged devices. Also, results depict that our system has several advantageous characteristics, such as: ease of network management and control motors and valves. There are five sensors adapted in the proposed design system, soil moisture, humidity, temperature, CO2, and light sensor, each of these sensors has measure changes in environment inside the greenhouse. Since, irrigation always starts when depletion different ratios available of all sensors to operate the devices plugged for different operations.

1.1. Introduction

The request for food has been growing day by day meanwhile the world population has been rising. It is noticeable that the agricultural products have to be enlarged in order not to be faced with starvation and people needs of foods. Greenhouses are the places where organized crop production took place. The governor of temperature, air humidity, light intensity, soil moisture, amount of carbon dioxide and wind velocity by specialists influence productivity. These parameters are related to each other.

The condition of supplying diverse environmental situations for each plant has drove researchers to use different monitoring systems[1].

It is convinced that the best suitable control system to use is portable system. The parameters are to be controlled can be handy devices.

It is intended to variety of monitoring for automation by using input parameter (temperature, light intensity, soil moisture, and the amount of carbon dioxide) in intended system based on Android devices[2]. Also, the input and output parameters used in greenhouse control were displayed within Android device. Finally, process of the input and output parameters of the system were measured and information was given about the rule base[3].

1.2. Sensors used in Greenhouses

Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. Carbon dioxide is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals). Human activities are altering the carbon cycle—both by adding more CO_2 to the atmosphere and by influencing the ability of natural sinks, like forests, to remove CO_2 from the atmosphere. While CO_2 emissions come from a variety of natural sources,

human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution [1].

Advantage of using greenhouse is to grow ornamental and food crops is the ability to provide desirable temperatures for plant growth and development. Providing a desired temperature is neither easy nor cheap. In greenhouse, a significant amount of energy is used to heat and ventilate them to maintain desirable temperature setpoints.

There is wide diversity of soil moisture sensors obtainable for use in greenhouse manufacture and research applications. Such sensors can play a valuable role in improving uniformity of substrate water content in greenhouses, as well as in automating irrigation based on plant water use. Quantification of spatial variability can be used to improve the design of irrigation systems to better match plant water use. The use of soil moisture sensors for irrigation control is promising, because it can greatly reduce temporal variability in substrate water content by watering based on actual crop water use [4].

1.3 Arduino UNO kit

Arduino is a kit using microcontroller to make the sense and control more flexible. This kit is an open source platform with simple board and development environment to write software. The main structure of Arduino is illustrated in figure (1).

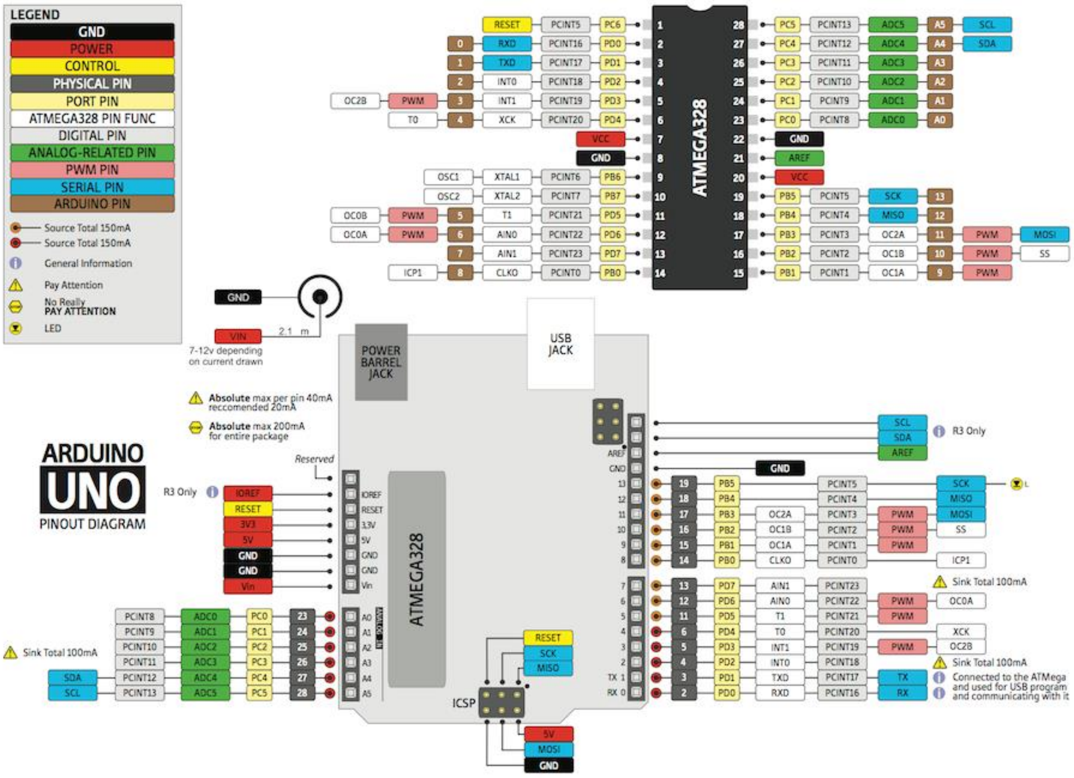

Figure (1) Arduino kit pin out description

The Arduino Uno consists of microcontroller board based on the ATmega328. This microcontroller 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.

1.4 The proposed greenhouse design

Plants found in greenhouse is affected by various factors, such as water in soil, and climatic conditions (temperature, humidity,..etc.). In this work, we've been focused on design and implementation for monitored climate conditions and to control the different devices on output (shutter, solenoid valve, and fan). Various inputs (sensors) and output (motors) are installed and connected to PC via controller circuit (Arduino UNO) determined as data acquisition. A graphical user interface has been designed using MS Visual Basic 2012 to retrieve and display the condition of climate by sensing data.

1.4.1 Hardware Description

The hardware design has been using Arduino UNO kit which consists of microcontroller ATMega32 and has multi inputs and outputs besides this microcontroller designed with ADCs and PWM. Below will describe each part of inputs and outputs used during design.

Inputs (Sensors)

A. DHT11 (Humidity and Temperature Sensor)

DHT11 sensor is used to measure temperature and humidity values, the DHT11 as shown in figure (2) the output of this sensor is digital and it has fast response time, good accuracy, and high resolution.

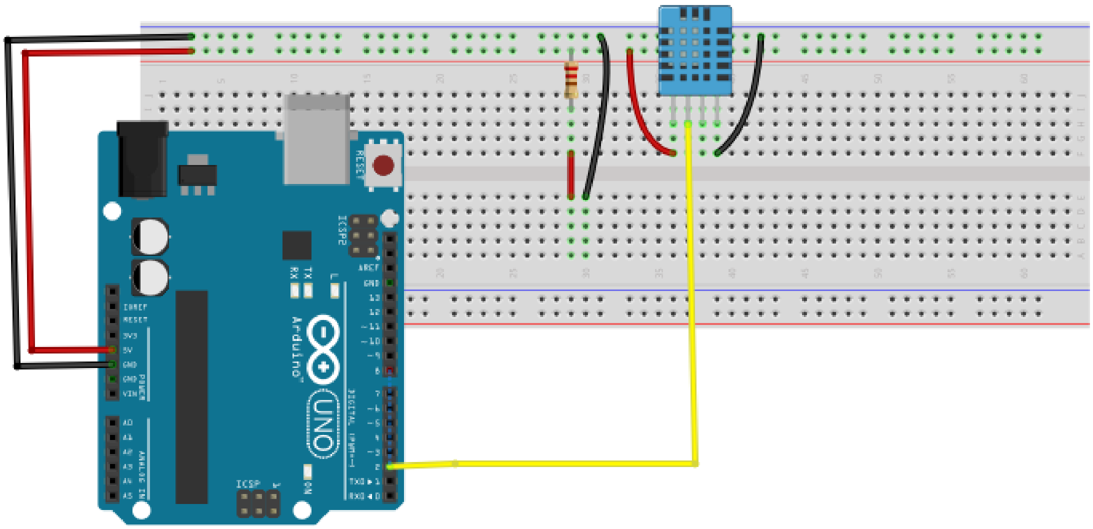

Figure (2) Wiring DHT11 sensor with Arduino UNO

Data form of DHT11 is 8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data + 8bit check sum. If the data transmission is valid, the check-sum should be the last 8bit of "8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data".

B. LDR

This sensor has located on outside of the greenhouse to receive the “sun” light. The LDR as shown in figure (3) receives flux (light intensity) and feedback loop moves the servo motor into the direction to close or open the shutter.

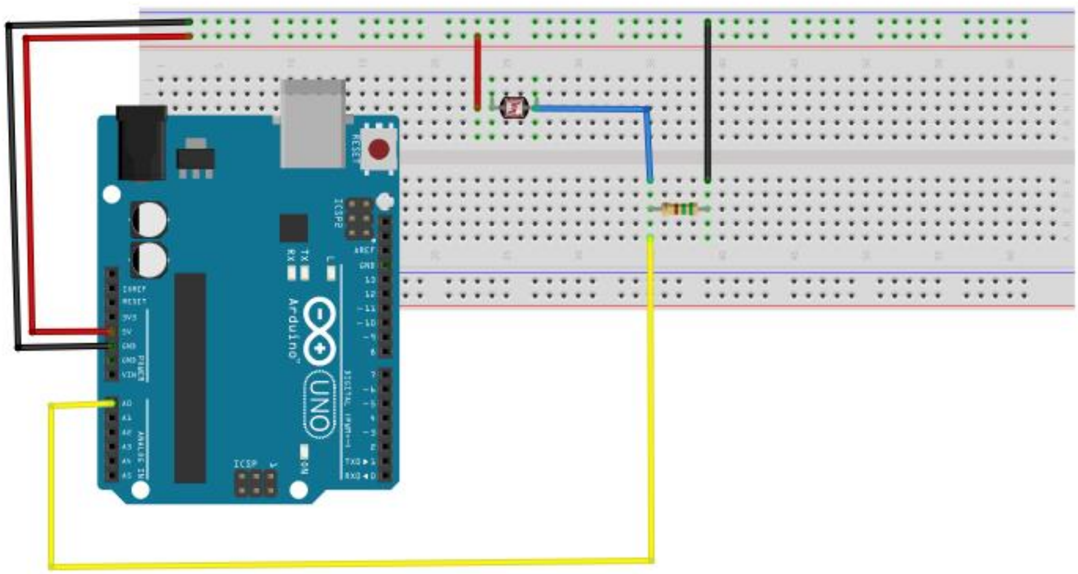

Figure (3) schematic circuit diagram of LDR sensor

C. CO2 Gas Sensor

In this research, we choose CO2 sensor. The detection range of CO2 sensor is 0~5000ppm. When concentration of CO2 is too high, then the design system will operate circulation fan.

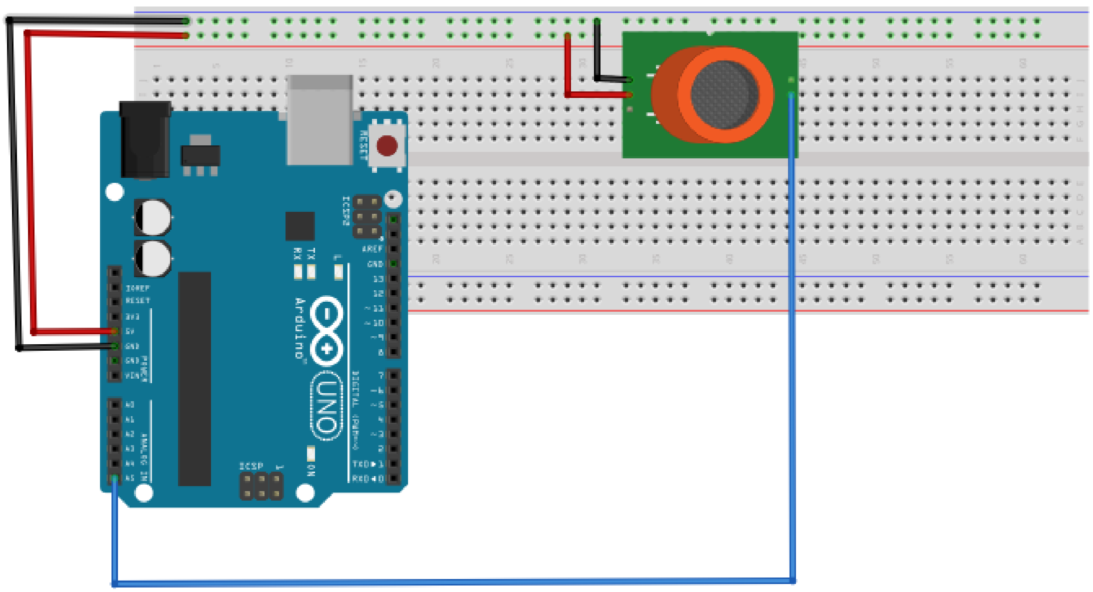

Figure (4) Schematic circuit diagram of co2 gas sensor

The level of CO2 gas is fixed such that when it goes above 30% the control device exhaust fan will get on by indicating relay and below it the reverse action takes place.

D. Moisture sensor

Other sensor is detection module soil moisture sensor had been used for greenhouse for monitoring and this module has the important benefit in process of irrigation. The schematic diagram of sensor is show in Figure (5).

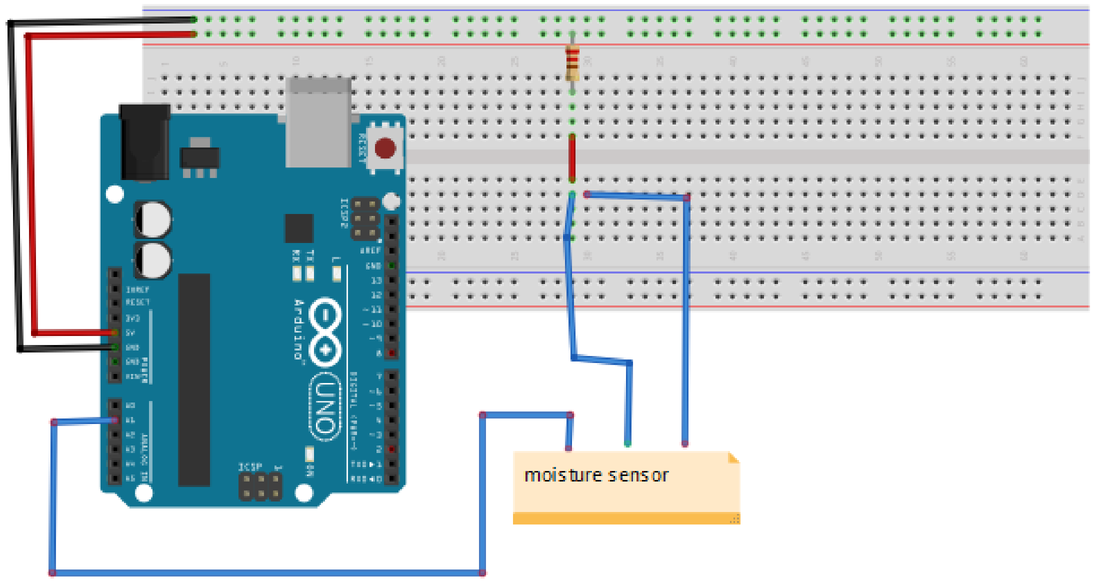

Figure (5) Schematic circuit diagram of moisture sensor

The set threshold value of sensing data of moisture soil sensor has been conditioned to switch the solenoid valve on output port. When the soil has get dry (less than 50%), will send a command to output port to operates the solenoid valve to start irrigating the soil.

2.2.2. Output Devices (Drivers)

A. Shutter

The light and temperature inside greenhouse has been controlled by shutter which operated using servo motor. The main concept of the ventilation is based on both light and temperture throughout the greenhouse, and as soon as the value set of light reaches different values will control device to open or close the shutter by moves the servo to the angle based on the value of light intensity. The circuit design of the servo motor shown in figure (6).

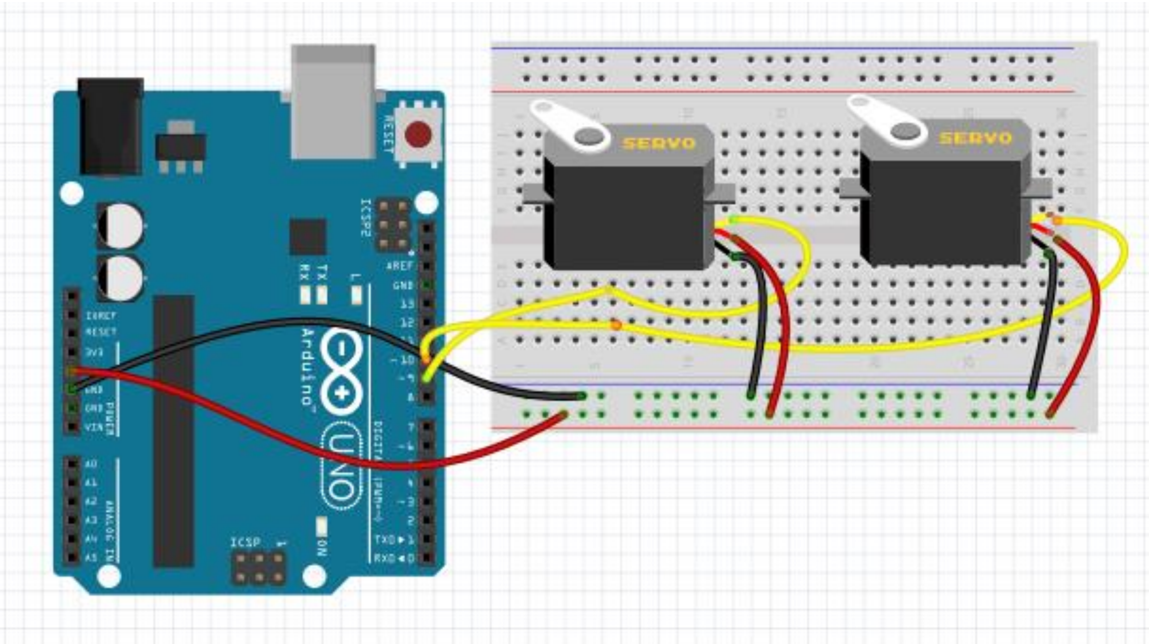

Figure (6) Schematic circuit diagram of shutter control

There has been used two servo motors, and has controlled by PWM Vpwm (1ms to 2ms for a 180° range). The maximum angle is (180^o) for full opened and the minimum angle is (0^o) in normal position (closed).

B. Fan Control

In the proposal design, if the temperature inside the greenhouse rise above 50 degree, there are two fans will be run. One if the fan operated to exhaust the heated air from inside greenhouse, meanwhile, other fun will operate to let the fresh air get inside the greenhouse. The schematic circuit of fan's driver illustrated in figure (7).

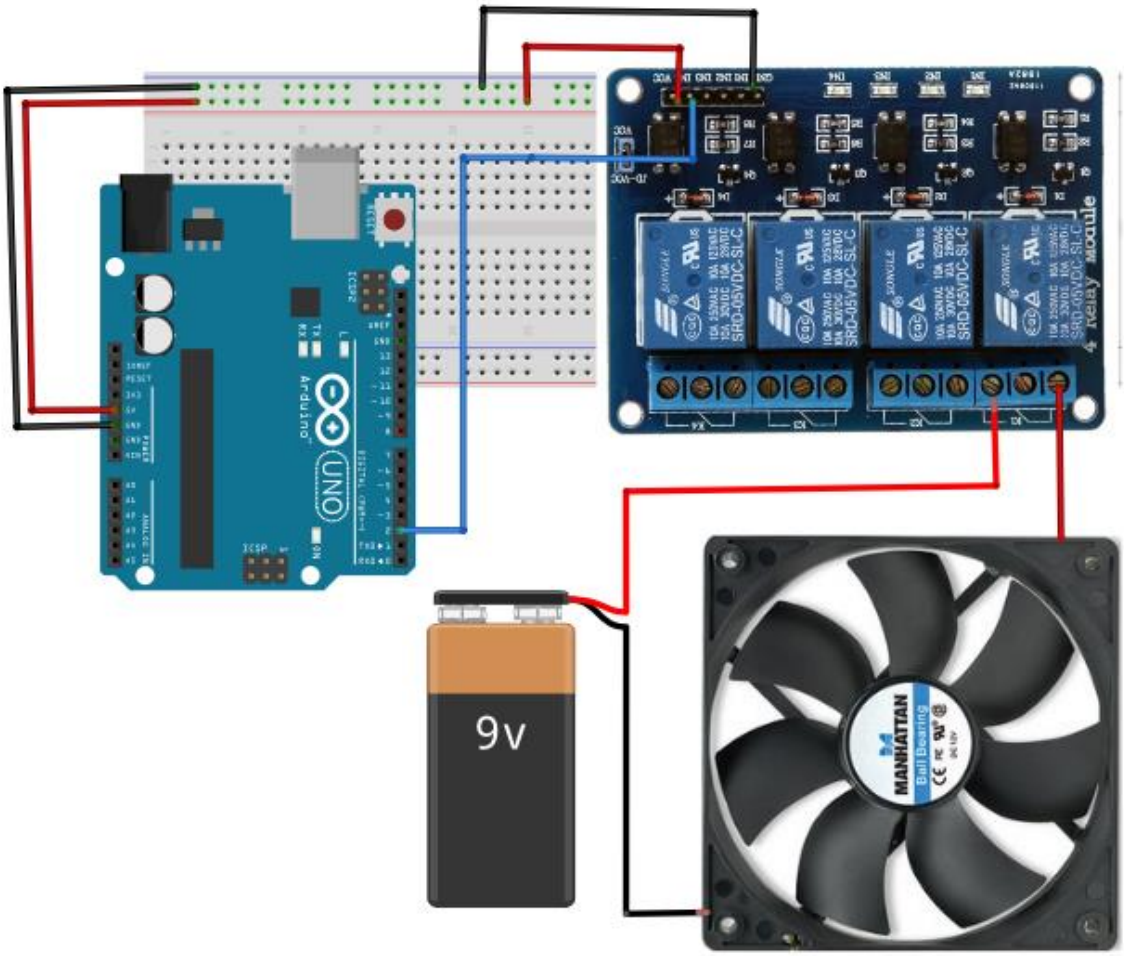

Figure (7) Schematic circuit diagram of fan' driver

C. Solenoid Valve Control

One of the important issue in design smart greenhouse is the sensing the value of water in soil. In the proposed design, we've used moisture soil sensor to measure if the soil needs to be irrigated or not, If the soil dries less than (50%), the solenoid valve will be operate to flow the water to soil from a water tank. The design control of solenoid is illustrated in figure (8).

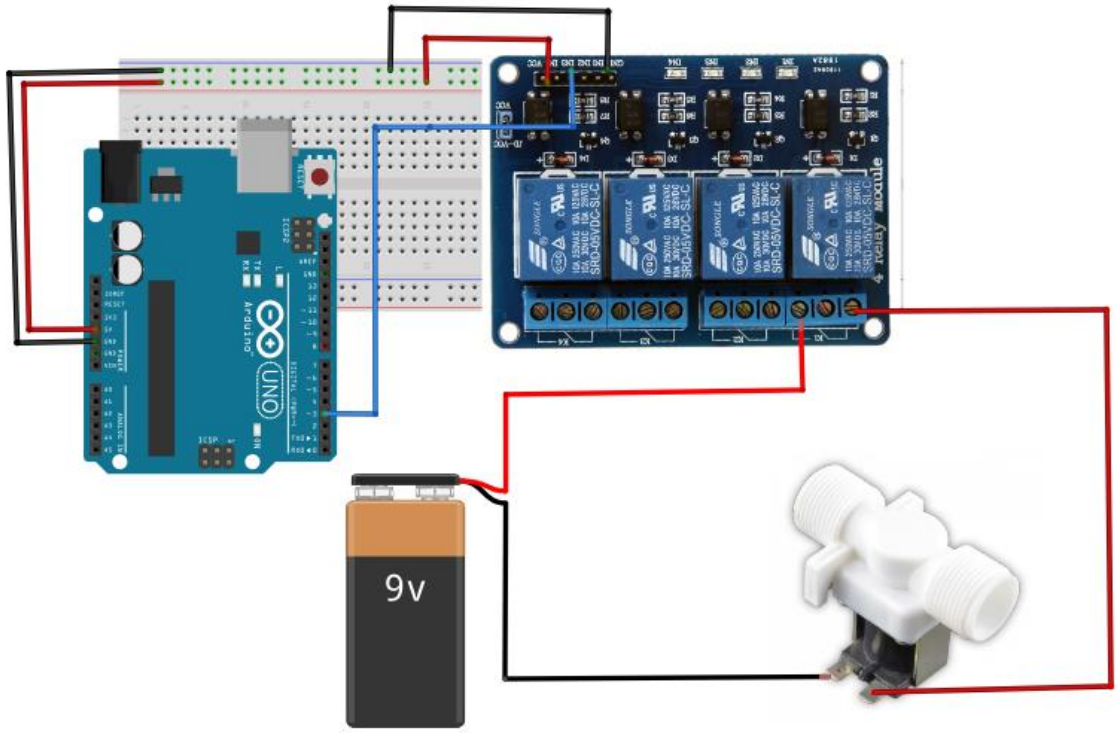

Figure (8) Schematic circuit diagram of solenoid valve control

3. System Monitoring Design

In client side (data logger interface) has been designed a Windows application to display data of sensors and transceiver the data to/from web server. The system monitoring designed to monitor different real-time data transmitted via interfaced electronic circuit deigned to get data of various sensors.

The system monitoring design in client side has been designed using Microsoft Visual Studio 2012 .NET as shown in figure below.

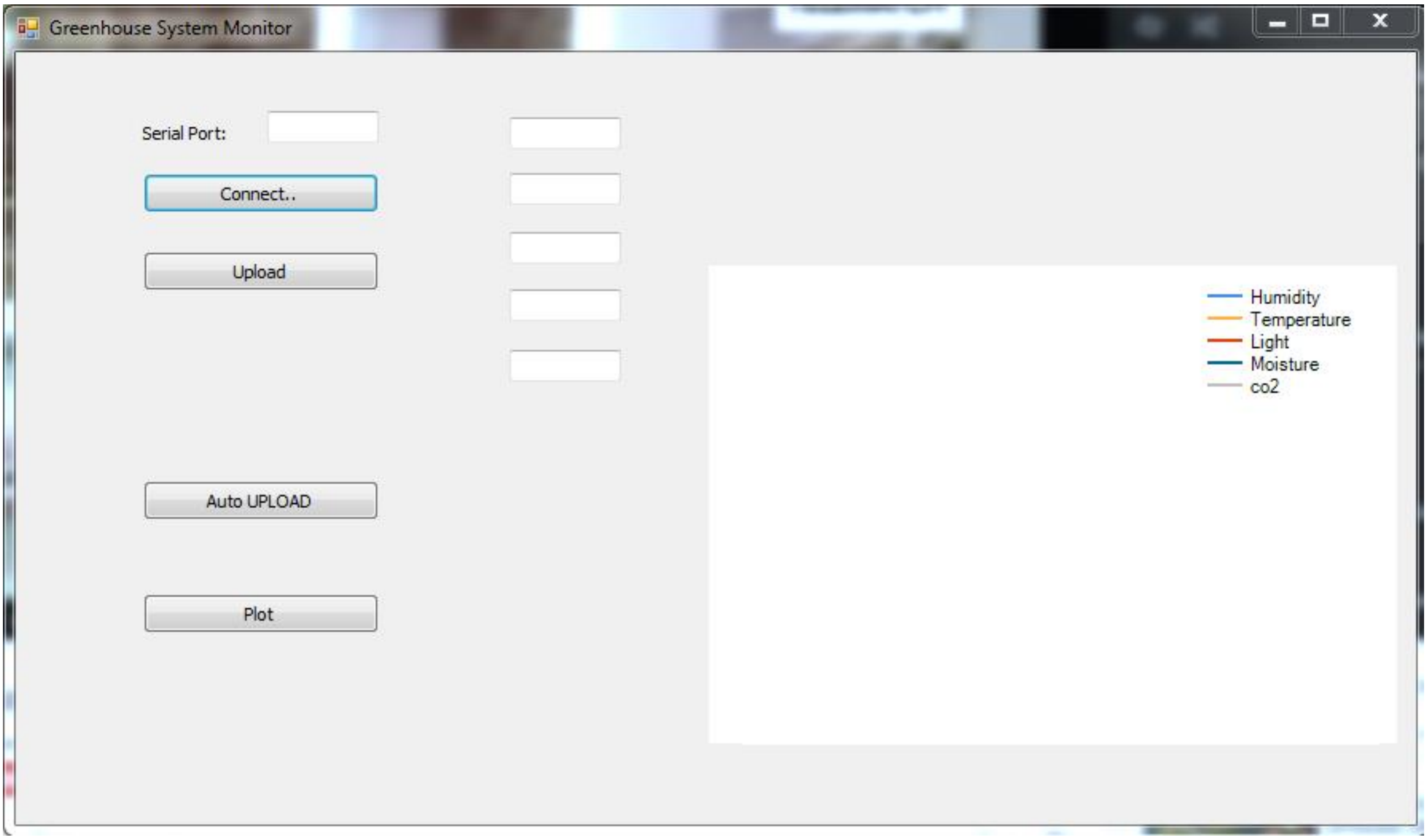

Figure (9) Design of proposed system monitoring

4. Server Database Design

The design of the server in this project used to publish the data of sensors and control commands uploaded by remote system monitoring. Google Docs server has provides several types of documents (word, spreadsheet, and presentation documents). In this project, we've design a spreadsheet to upload and retrieve data from master system monitoring and remote system monitoring. The number of fields needed in the server design is (6) fields represent the data of sensors and time as shown in figure below.

A	B	C	D	E	F
Timestamp	humidity	temperature	light	moisture	co2
7/14/2015 4:15:51	30	22	12	0	10
7/14/2015 4:17:35	30	22	12	0	11
7/14/2015 4:41:43	27	21	12	0	11
7/14/2015 4:41:59	27	21	12	66	8
7/14/2015 4:42:19	26	21	12	65	10
7/14/2015 4:42:22	26	21	12	65	9
7/14/2015 4:42:24	26	21	12	65	10
7/14/2015 4:42:26	25	21	12	65	11
7/14/2015 4:43:08	25	21	12	65	9
7/14/2015 4:50:30	25	21	12	65	10
7/14/2015 5:25:58	26	21	13	68	8

Figure (10) Spreadsheet design in Google Docs server

The relation between the data of sensors and the time show in figure below

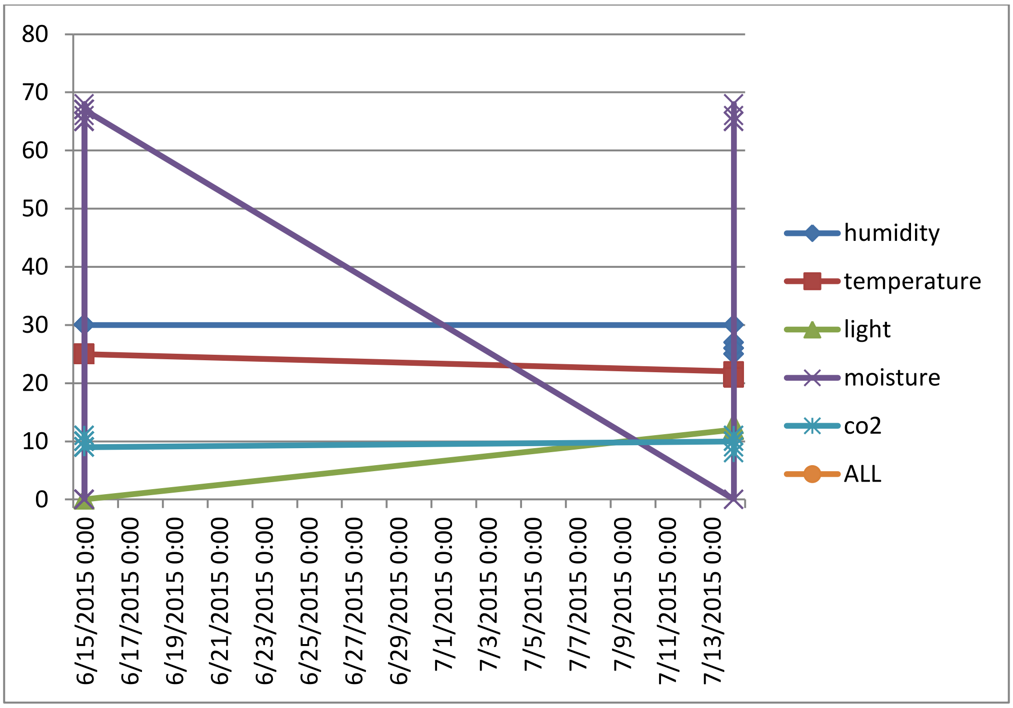

Figure (11) the data of sensors and time

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