AUTO IRRIGATION SYSTEM USING ARDUINO

By

Omar nabeil	**170021158**
Mohammed J.S Abuiyada	**170021164**
Ismail Alamin	**170021174**
Ibrahim El-hadj	**180021142**
Khader Almadhun	**180021243**

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Approved by:

Mr. Ahmad Shafiullah

Lecturer,
Department of Electrical and Electronic Engineering
Islamic University of Technology (IUT)
Board bazar, Gazipur-1704.

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Declaration of Authorship

This is to certify that the work in this thesis paper is the outcome of research carried out by the students under the supervision of Mr. Ahmad Shafiullah, lecturer and Department of Electrical and Electronic Engineering (EEE), Islamic University of Technology (IUT).

Authors

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Omar Nabeil Anaiah
ID-170021158

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Mohammed J.S Abuiyada
ID-170021164

____
Ismail Alamin
ID-170021174

____
Ibrahim El-hadj
ID-180021142

____
Khader Almadhun
ID-180021243

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1. Introduction

By using the concept of modern irrigation system, a farmer can save water up to 50%. This concept depends on two irrigation methods those are: conventional irrigation methods like overhead sprinklers, flood type feeding systems i.e., wet the lower leaves and stem of the plants. The area between the crop rows become dry as the large amount of water is consumed by the flood type methods, in which case the farmer depends only on the incidental rainfalls. The crops are been infected by the leaf mold fungi as the soil surface often stays wet and is saturated after irrigation is completed.

Overcoming these drawbacks new techniques are been adopted in the irrigation techniques, through which small amounts of water applies to the parts of root zone of a plant. The plant soil moisture stress is prevented by providing required amount of water resources frequently or often daily by which the moisture condition of the soil will retain well. The diagram below shows the entire concept of the modern irrigation system. The traditional techniques like sprinkler or surface irrigation requires / uses nearly half of water sources. Even more precise amounts of water can be supplied for plants. As far as the foliage is dry the plant damage due to disease and insects will be reduced, which further reduces the operating cost.

The dry rows between plants will leads to continuous federations during the irrigation process. Fertilizers can be applied through this type of system, and the cost required for will also reduces. The erosion of soil and wind is much reduced by the recent techniques when compared with overhead sprinkler systems. The soil characteristics will define the form of the dripping nature in the root zone of a plant which receives moisture.

As the method of dripping will reduce huge water losses it became a popular method by reducing the labor cost and increasing the yields. When the components are activated, all the components will read and gives the output signal to the controller, and the information will be displayed to the user (farmer). The sensor readings are analog in nature so the ADC pin in the controller will convert the analog signals into digital format. Then the controller will access information and when the motors are turned on/Off it will be displayed on the LCD Panel.

2. Objective of Project

There is an urgent need for a system that makes the agricultural process easier and burden free from the farmer's side. With the recent advancement of technology, it hasbecome necessary to increase the annual crop production output entirely agro-centric economy.

The ability to conserve the natural resources as well as giving a splendid boost to the production of the crops is one of the main aims of incorporating such technology into the agricultural domain of the country.

To save farmers effort, water and time. Irrigation management is a complex decision-making process to determine when and how much water to apply to a growing crop to meet specific management objectives.

If the farmer is far from the agricultural land he will not be noticed of current conditions. So, efficient water management plays an important role in the Irrigated agricultural cropping systems.

3. Literature Survey

It is a simple project more useful in watering plants automatically without any human interference. We know that people do not pour the water on to the plants in their gardens when they go to vacation or often forget to water plants. As a result, there is a chance to get the plants damaged. This project is an excellent solution for such kind of problems. Many irrigation systems exit such as,

1. Monitoring of rice crops using GPRS and wireless sensors for efficient use of water and Electricity.
2. Wireless Sensor Based Remote Monitoring System for Agriculture Using ZigBee and GPS.
3. Design of Embedded System for the Automation of Drip Irrigation.
4. A Survey of Automated GSM Based Irrigation System.
5. Wireless Sensor Networks Agriculture: For Potato Farming.
6. Design and Implementation of GSM based Irrigation System Using ARM7.
7. Automated Irrigation System Using a Wireless Sensor Network and GPRS Module.
8. Automated Irrigation System Using Solar Power.
9. Review for ARM based agriculture field monitoring system.
10. Automatic Irrigation Control by using wireless sensor networks.
11. Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network.

4. Problem Statement

Irrigation of plants is usually a very time- consuming activity, to be done ina reasonable amount of time, it requires a large number of human resources. Traditionally all the steps were executed by humans. Nowadays some systems use technology to reduce the number or workers or the time required to water the plants. With such systems, the control is very limited, and many resources are still wasted.

Water is one of these resources that are used excessively. Many irrigations are one method used to water the plant. This method represents massive losses since the amountof water given is in excess of the plants needs. The excess water is evacuated by the holes of the pots in greenhouses, or it percolates through the soil in the fields.

The contemporary perception of water is that of a free renewable resource that can be used in abundance. It is therefore reasonable to assume that it will soon become a very expensive resource everywhere.

In addition to the excess cost of water labor is becoming more and more expensive. As a result, if no effort is invested in optimizing these resources, there will be more money involved in the same process. Technology is probably a solution to reduce costs and prevent loss of resource, this project can be a strong way to tackle such a situation.

5. Scope of project

Day by day, the field of electronics is blooming and have caused great impact on human beings. The project which is to be implemented is an automated irrigation method and has a huge scope for future development. The project can be extended to greenhouses where manual supervision is far and few in between. The principle can be extended to create fully automated gardens and farmlands. Combined with the principle of rain water harvesting, it could lead to huge water savings if applied in the right manner. In agricultural lands with severe shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.

By developing a Smart Wireless Sensor and by using upcoming techniques a farmer can increase his profit by solving different problems that are faced by the farmer in his routine life. And also, to involve Arduino – Controller with a video capturing by using an MMS facility about the crop position and at the same time sending video to the farmer.

6. Adopted Methodology

PROJECT PLANNING

a. Analysis of the exiting situation and the exact nature of problem faced through discussions with the project guide.

b. Study of process of different technologies used in the system.

c. With the help of the guide the specifications of the program were decided and then implemented in the project.

d. Use of Accelerometer sensor to interface the computer and embedded system meant for process and control.

e. Testing, development and troubleshooting still underway to enhance user interface.

6.1 Block Diagram

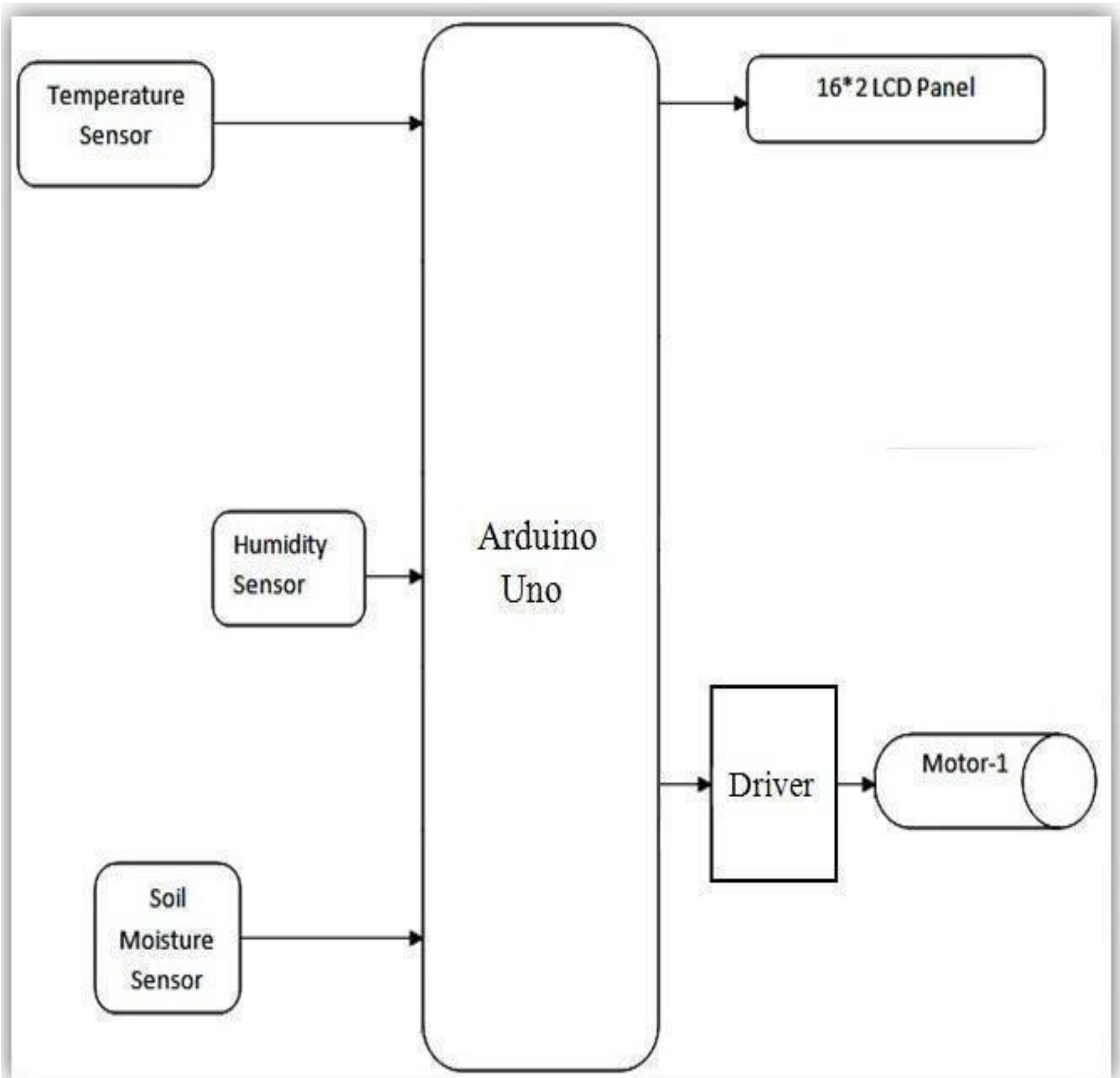

Fig1: Block Diagram

Above is the manner in which we are going to implement the circuit. The first part of the block diagram are different sensors and the second part is an LCD Panel and motors for supplying water. The major hardware modules which are needed: Arduino processor, motor, different sensors and an LCD Panel.

6.2 Hardware and Software Component:

I. Temperature Sensor (LM35):

The temperature sensor used to measure the temperature at the field is LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade). The LM35 does not require any external calibration or trimming to provide typical accuracies of degree C at room temperature and degree C over a full -55 to +150C temperature range. Low cost is assured by

trimming and calibration at the wafer level. The LM35‟s low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 μA from the supply, it has very low self-heating of less than 0.1°C in still air.

Features

1. Calibrated Directly in Celsius (Centigrade)
2. Linear + 10-mV/°C Scale Factor
3. 0.5°C Ensured Accuracy (at 25°C)
4. Rated for Full −55°C to 150°C Range
5. Suitable for Remote Applications
6. Low-Cost Due to Wafer-Level Trimming
7. Operates from 4 V to 30 V
8. Less than 60-μA Current Drain
9. Low Self-Heating, 0.08°C in Still Air
10. Non-Linearity Only ±¼°C Typical
11. Low-Impedance Output, 0.1 Ω for 1-mA Load

Fig2: LM35

	LM35	LM135	LM135A	LM235	LM335
Local Sensor Accuracy (Max) (+/- C)	0.5	3	1	3	6
Operating Temperature Range (C)	-40 to 110 -55 to 150 0 to 100 0 to 70	-55 to 150	-55 to 150	-40 to 125	-40 to 100
Supply Voltage (Min) (V)	4	5	5	5	5
Supply Voltage (Max) (V)	30				
Supply Current (Max) (uA)	114	400	400	400	400
Sensor Gain (mV/Deg C)	10	10	10	10	10
Rating	Military	Military	Military	Military	Military
Shutdown	No	No	No	No	No
Output Impedance (Ohm)	0.4	0.5	0.5	0.5	0.6
Interface	Analog Output	Analog Output	Analog Output	Analog Output	Analog Output

Fig3: Temp Sensor Variances

II. Humidity Sensor (DHT11):

A Humidity sensor also called a hygrometer, measures and regularly reports the relative humidity in the air. A humidity sensor senses relative humidity. This means that it measures both air temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature. The most common type of humidity sensor uses what is called “capacitive measurement

This system relies on electrical capacitance, or the ability of two nearby electrical conductors to create an electrical field between them. The sensor itself is composed of two metal plates with a non-conductive polymer film between them. The film collects moisture from the air, and the Moisture causes minute changes in the voltage between the two plates. The changes in voltage are converted into digital readings showing the amount of moisture in the air

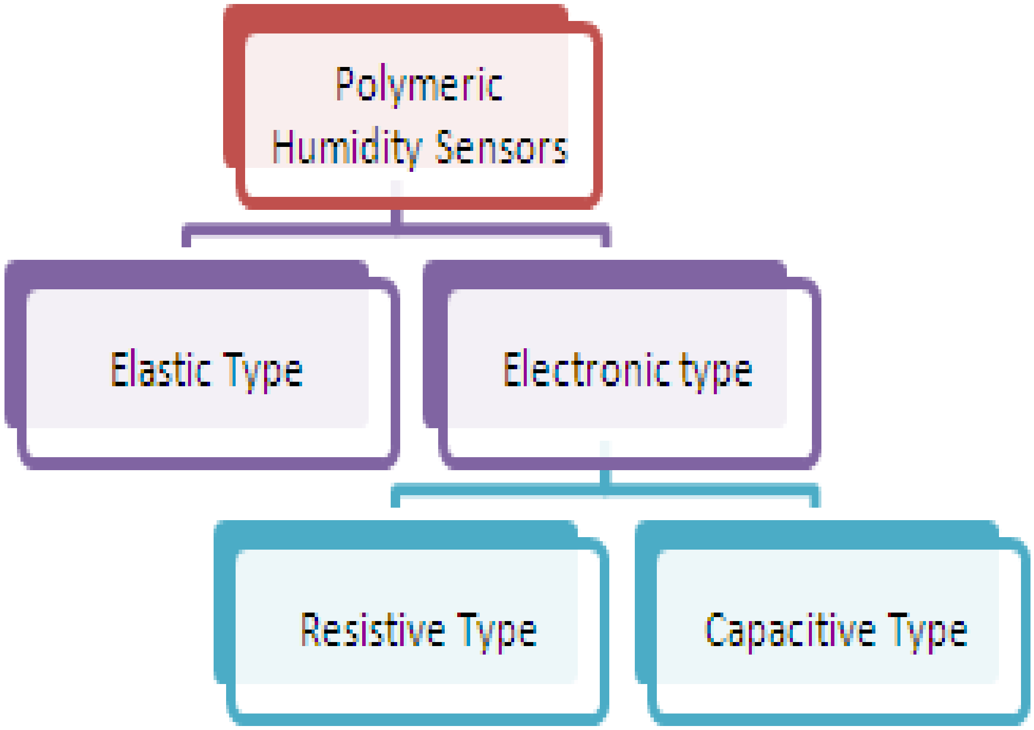

Fig4: DHT11 Sensor

A table showing important parameters of different types of humidity sensors is given below:

Active Material	Thermo-set Polymer	Thermoplastic Polymer	Thermoplastic Polymer	Bulk Thermoplastic	Bulk AlO3	Lithium Chloride Film
Substrate	Ceramic or Silicon	Ceramic or silicon	Polyester or mylar film	N/A	N/A	Ceramic
Sensed Parameter	Capacitance	Capacitance	Capacitance	Resistance	Resistance	Conductivity
Measured Parameter	%RH	%RH	%RH	%RH	%RH	%RH
RH Change	0% to 100%	0% to 100%	0% to 100%	20% to 100%	2% to 90%	15% to <100%
RH Accuracy	±1% to ±5%	±3% to ±5%	±3% to ±5%	±3% to ±10%	±1% to ±5%	±5%
Interchangability	±2% to ±10% RH	±3% to ±20% RH	±3% to ±20% RH	±5% to ±25% RH	poor	±3% to ±10% RH
Hysterisis	<1% to 3% RH	2% to 5% RH	2% to 5% RH	3% to 6% RH	<2% RH	very poor
Linearity	±1% RH	±1% RH	±2% RH	poor	poor	Very poor
Risetime	15 s to 60 s	15 s to 90 s	15 s to 90 s	2 min to 5 min	3 min to 5 min	3 min to 5 min
Temperature Range	-40 °C to 185 °C	-30 °C to 190 °C	-25°C to 100 °C	10 °C to 40 °C	-10 °C to 75 °C	-
Long Term Stability	±1%RH/5 yr	±1%RH/yr	±1%RH/yr	±3%RH/yr	±3% RH/yr	>1% RH/°C

Table1: parameters of different types of humidity sensor

III. Soil Moisture Sensor:

Although soil water status can be determined by *direct* (soil sampling) and *indirect* (soil moisture sensing) methods, direct methods of monitoring soil moisture are not commonly used for irrigation scheduling because they are intrusive and labor intensive and cannot provide immediate feedback. Soil moisture probes can be permanently installed at representative points in an agricultural field to provide repeated moisture readings over time that can be used for irrigation management. Special care is needed when using soil moisture devices in coarse soils since most devices require close contact with the soil matrix that is sometimes difficult to achieve in these soils.

Most of the currently available volumetric sensors suitable for irrigation are dielectric. This group of sensors estimate soil water content by measuring the soil bulk permittivity (or dielectric constant) that determines the velocity of an electromagnetic wave or pulse through the soil. In a composite material like the soil (i.e., made up of different components like minerals, air and water), the value of the permittivity is made up by the relative contribution of each of the components. Since the dielectric constant of liquid water is much larger than that of the other soil constituents, the total permittivity of the soil or bulk permittivity is mainly governed by the presence of liquid water. The dielectric methods use empirical (calibrated) relationships between volumetric water content and the sensor output signal (time, frequency, impedance, wave phase). These techniques are becoming widely adopted because they have good response time (almost instantaneous measurements), do not require maintenance, and can provide continuous readings through automation. Although these sensors are based on the dielectric principle the various types available (frequency domain reflectometry-FDR, capacitance, time domain transmission-TDT, amplitude domain reflectometry-ADR, time domain reflectometry-TDR, and phase transmission) present important differences in terms of calibration requirements, accuracy, installation and maintenance requirements and cost.

Soil moisture is an important component in the atmospheric water cycle, both on a small agricultural scale and in large-scale modelling of land/atmosphere interaction. Vegetation and crops always depend more on the moisture available at root level than on precipitation occurrence. Water budgeting for irrigation planning, as well as the actual scheduling of irrigation action, requires local soil moisture information. Knowledge of the degree of soil wetness helps to forecast the risk of flash floods, or the occurrence of fog.

Soil water content is an expression of the mass or volume of water in the soil, while the soil water potential is an expression of the soil water energy status. The relation between content and potential is not universal and depends on the characteristics of the local soil, such as soil density and soil texture.

The basic technique for measuring soil water content is the gravimetric method. Because this method is based on direct measurements, it is the standard with which all other methods are compared. Unfortunately, gravimetric sampling is destructive, rendering repeat measurements on the same soil sample impossible. Because of the difficulties of accurately measuring dry soil and water volumes, volumetric water contents are not usually determined directly.

Measuring soil moisture is very important in agriculture to help farmer for managing the irrigation system. Soil moisture sensor is one who solves this. This sensor measures the content of water. Soil moisture sensor uses the capacitance to measure the water content of soil. It is easy to use this sensor. Simply insert this rugged sensor into the soil to be tested, and the volumetric water content of the soil is reported in percent. Soil moisture sensors measure the volumetric water content in soil.

Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks.

Fig5: soil moisture sensor

IV. Arduino Micro-controller:

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. We can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so we use the Arduino programming language (based on wiring), and the Arduino Software (IDE), based on Processing.

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Table2: Arduino Features

FEATURE	SPECIFICATION
Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

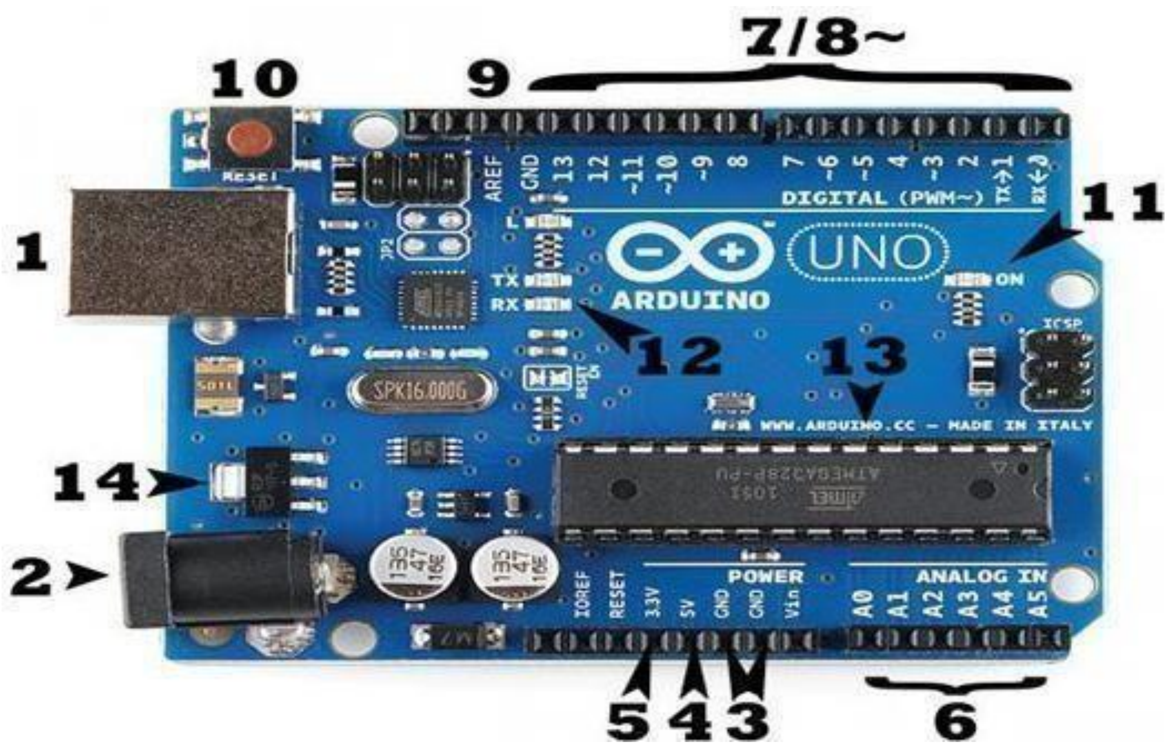

Fig6: Arduino UNO

4.1 What Does it Do?

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects.

4.2 What's on the board?

There are many varieties of Arduino boards (explained on the next page) that can be used for different purposes. Some boards look a bit different from the one below, but most Arduinos have the majority of these components in common

4.3 Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply (like this) that is terminated in a barrel jack. In the picture above the USB connection is labeled (1) and the barrel jack is labelled (2). The USB connection is also how you will load code onto your Arduino board.

4.4 Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to construct a circuit probably in conjunction with a breadboard and some wire. They usually have black plastic headers that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

GND (3): Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.

5V (4) & 3.3V (5): As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

Analog (6): The area of pins under the ‘Analog In’ label (A0 through A5 on the UNO) is Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.

Digital (7): Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).

AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

4.5 Reset Button

Just like the original Nintendo, the Arduino has a reset button (10). Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn’t repeat, but you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn’t usually fix any problems.

4.6 Power LED Indicator

Just beneath and to the right of the word “UNO” on your circuit board, there’s a tiny LED next to the word „ON“ (11). This LED should light up whenever you plug your Arduino into a power source. If this light doesn’t turn on, there’s a good chance something is wrong. Time to re-check your circuit!

4.7 TX RX LEDs

TX is short for transmit; RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs (12). These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we're loading a new program onto the board).

4.8 Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit (13). Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the A Tmega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC‟s, reading the datasheets is often a good idea.

4.9 Voltage Regulator

The voltage regulator (14) is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says – it controls the amount of voltage that is let into the Arduino board. Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don't hook up your Arduino to anything greater than 20 volts.

4.10 The Arduino Family

Arduino makes several different boards, each with different capabilities. In addition, part of being open-source hardware means that others can modify and produce derivatives of Arduino boards that provide even more form factors and functionality

V. LCD Panel:

A liquid-crystal display (LCD) is a flat-panel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly.

LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in nearly all applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters (parallel and perpendicular), the axes of transmission of which are (in most of the cases) perpendicular to each other.
Without the liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

Before an electric field is applied, the orientation of the liquid-crystal molecules is determined by the alignment at the surfaces of electrodes. In a twisted nematic (TN) device, the surface alignment directions at the two electrodes are perpendicular to each other, and so the molecules arrange themselves in a helical structure, or twist. This induces the rotation of the polarization of the incident light, and the device appears gray. If the applied voltage is large enough, the liquid crystal molecules in the center of the layer is almost completely untwisted and the polarization of the incident light is not rotated as it passes through the liquid crystal layer. This light will then be mainly polarized perpendicular to the second filter, and thus be blocked and the pixel will appear black. By controlling the voltage applied across the liquid crystal layer in each pixel, light can be allowed to pass through in varying amounts thus constituting different levels of gray.

As most of present-day LCDs used in television sets, monitors and smart phones have high-resolution matrix arrays of pixels to display arbitrary images using backlighting with a dark background when no image is displayed, different arrangements are used. For this purpose, TN LCDs is operated between parallel polarizers, whereas IPS LCDs feature crossed polarizers. In many applications IPS LCDs have replaced TN LCDs, in particular in smart phones such as iPhones.

Both the liquid crystal material and the alignment layer material contain ionic compounds. If an electric field of one particular polarity is applied for a long period of time, this ionic material is attracted to the surfaces and degrades the device performance. This is avoided either by applying an alternating current or by reversing the polarity of the electric field as the device is addressed (the response of the liquid crystal layer is identical, regardless of the polarity of the applied field).

This is a basic 16 character by 2-line display.16×2 LCD module is a very common type of LCD module that is used in 8051 based embedded projects. It consists of 16 rows and 2 columns of 5×7 or 5×8 LCD dot matrices. The module was are talking about here is type number JHD162A which is a very popular one. It is available in a 16-pin package with back light, contrast adjustment function and each dot matrix have 5×8 dot resolution. The pin numbers, their name and corresponding functions are shown in the table below.

Pin No:	Name	Function
1	VSS	This pin must be connected to the ground
2	VCC	Positive supply voltage pin (5V DC)
3	VEE	Contrast adjustment
4	RS	Register selection
5	R/W	Read or write
6	E	Enable
7	DB0	Data
8	DB1	Data
9	DB2	Data
10	DB3	Data
11	DB4	Data
12	DB5	Data
13	DB6	Data
14	DB7	Data
15	LED+	Back light LED+
16	LED-	Back light LED-

Table3: LCD Panel

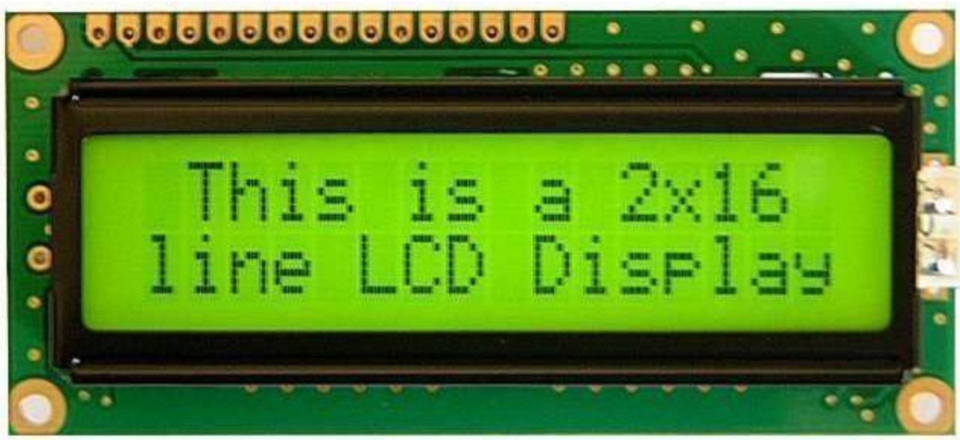

Fig7: LCD Display

VI. Water Pump:

The water pump is used to artificially supply water for a particular task. It can be electronically controlled by interfacing it to a microcontroller. It can be triggered ON/OFF by sending signals as required. The process of artificially supplying water is known as pumping. There are many varieties of water pumps used. This project employs the use of a small water pump which is connected to a H-Bridge.

The pumping of water is a basic and practical technique, far more practical than scooping it up with one's hands or lifting it in a hand-held bucket. This is true whether the water is drawn from a fresh source, moved to a needed location, purified, or used for irrigation, washing, or sewage treatment, or for evacuating water from an undesirable location. Regardless of the outcome, the energy required to pump water is an extremely demanding component of water consumption. All other processes depend or benefit either from water descending from a higher elevation or some pressurized plumbing system.

Fig8: Water pump

VII. Motor Driver:

Because of very low current requirement, these motors can easily operate with small batteries and solar panels. Quiet and smooth operation of this motor makes it a perfect choice for indoor and long hours of operation.

Direction of rotation: Counter-Clockwise when viewing from the output shaft end with positive voltage applied to positive terminal.

Fig9: Motor Driver

Specifications:

Operating range: 3.0 – 12.0 Volts
Nominal Voltage: 12
No Load Speed: 5600
rpm No Load Current:
0.022 A
Max. Efficiency Speed: 4906 rpm
Max. Efficiency Current: 0.16 -0.23 A
Max. Efficiency Torque: 21.1 g.cm
Stall Torque: 170 g.cm
Stall Current: 1.1 – 1.5 A
Body Diameter: 24.4 mm
Body Length: 32.5 mm
Shaft Diameter: 2 mm
Shaft Length: 10.5 mm
Weight: 50 grams
Contacts: 2mm x 3.9mm
End Play: 0.05 ~
0.45mm
Operating Temperature: -10ºC ~ 60ºC

VIII. DESCRIPTION OF ATMEGA 328P MICRO CONTROLLER:

The ATmega48PA/88PA/168PA/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the Atmega48PA/88PA/168PA/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed The Atmega48PA/88PA/168PA/328P provides the following features: 4K/8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1K bytes EEPROM, 512/1K/1K/2K bytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning.

The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle.

The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset. The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel Atmega48PA/88PA/168PA/328P is a powerful microcontroller that provides a highly flexible and cost-effective solution to many embedded control applications. The Boot program can use any interface to download the application program in the Application Flash memory. This allows very fast start-up combined with low power consumption.

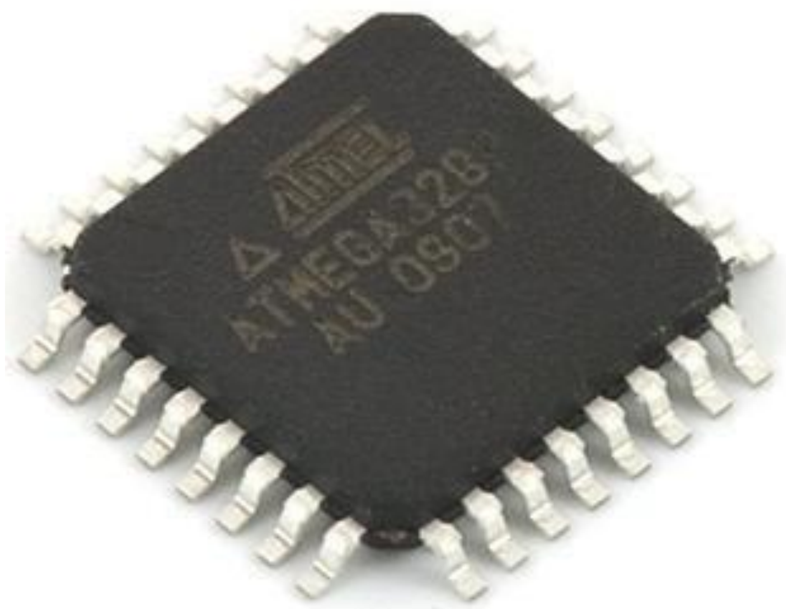

Fig10: ATMEGA 328P MICRO CONTROLLER

Even though there are separate addressing schemes and optimized opcodes for register file and I/O register access, all can still be addressed and manipulated as if they were in SRAM. In the ATMEGA variant, the working register file is not mapped into the data address space; as such, it is not possible to treat any of the ATMEGA's working registers as though they were SRAM.

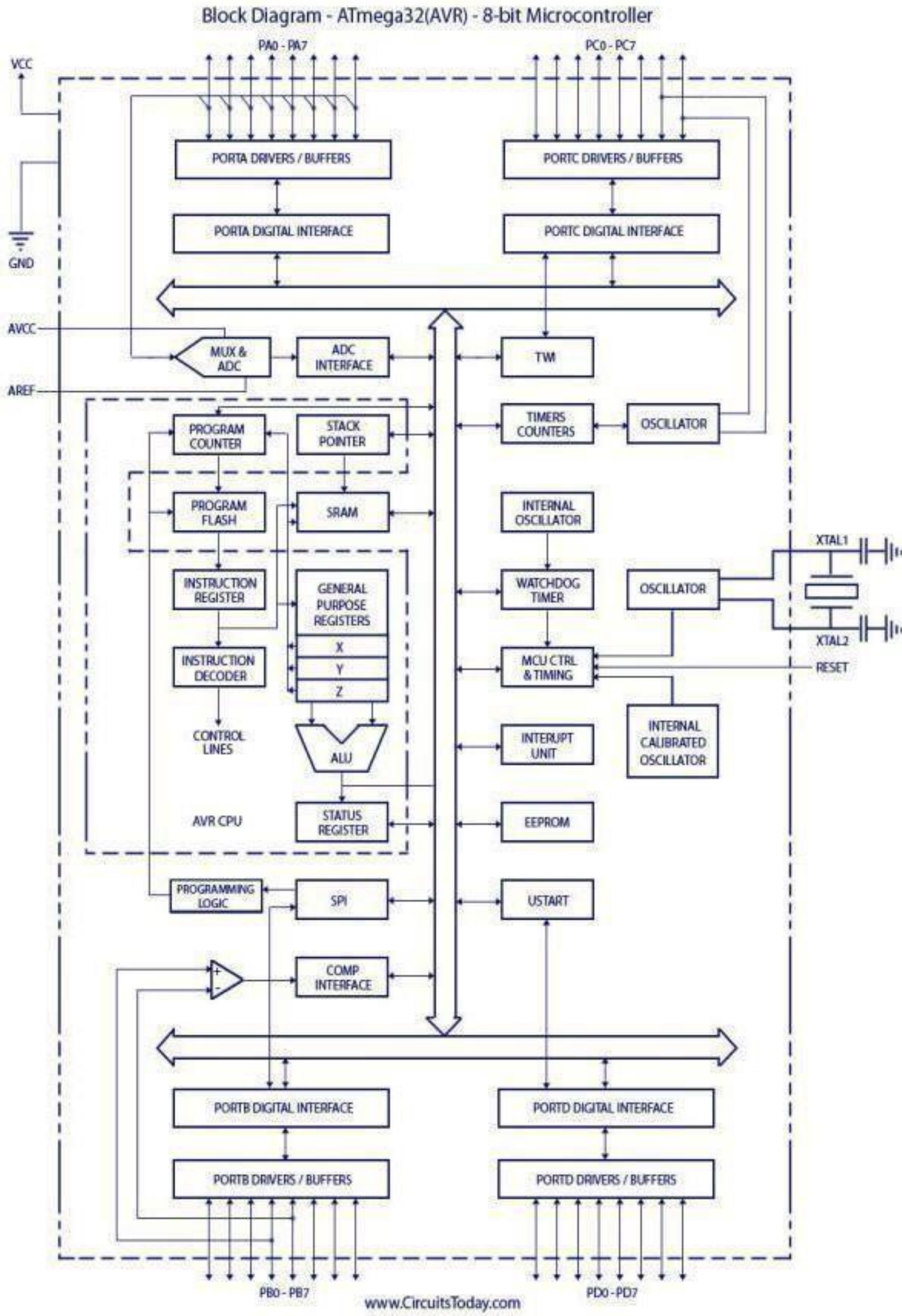

Fig11: Pin configuration

XI. History of AVR

AVR was developed in the year 1996 by Atmel Corporation. The architecture of AVR was developed by Alf-Egil Bogen and Vegard Wollan. AVR derives its name from its developers and stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller, also known as Advanced Virtual RISC. The AT90S8515 was the first microcontroller which was based on AVR architecture however the first microcontroller to hit the commercial market was AT90S1200 in the year 1997.

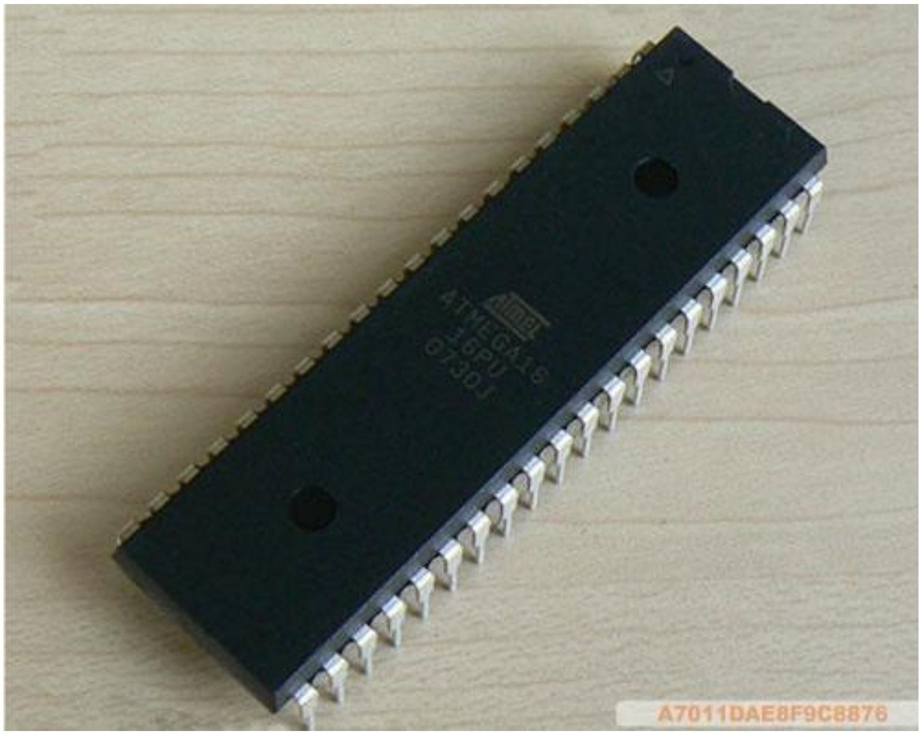

Fig12: AVR Microcontroller

AVR stands for advance virtual RISC.

AVR microcontrollers are available in three categories:

1. Tiny AVR – Less memory, small size, suitable only for simpler applications
2. Mega AVR – These are the most popular ones having good amount of memory (up to 256 KB), higher number of inbuilt peripherals and suitable for moderate to complex applications.
3. mega AVR – Used commercially for complex applications, which require large program memory and high speed.

6.3 MAJOR SOFTWARE REQUIRED

I. **Arduino Software (IDE)**:

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. For latest software refer to link. https://www.arduino.cc/en/Main/Software

- ✓ Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students with or without a background in electronics and programming.
- ✓ Arduino is an open-source prototyping platform based on easy-to-use hardware and software.
- ✓ Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a message - and turn it into an output - activating a motor, turning on an LED, publishing something online and many more.
- ✓ You can tell your board what to do by sending a set of instructions to the microcontroller on the board.
- ✓ To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms.

- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well.

- **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it.

- **Open source and extensible software** - The Arduino software is published as open source tool and the language can be expanded through C++ libraries.

II. How to use Arduino IDE Tool

Steps for using Arduino IDE:

Step 1: Get an Arduino board and USB cable:

In this tutorial, we assume you're using an Arduino Uno You also need a standard USB cable (A plug to B plug): the kind you would connect to a USB printer, for example.

Step 2 : Download the Arduino environment:

(https://www.arduino.cc/en/Main/Software**)**

Get the latest version from the download page. When the download finishes, unzip the downloaded file. Make sure to preserve the folder structure. Double-click the folder to open it. There should be a few files and sub-folders inside.

Step 3 : Connect the board:

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either the USB connection to the computer or an external power supply. If you're using an Arduino Diecimila, you'll need to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it's on the two pins closest to the USB port. Connect the Arduino board to your computer using the USB cable. The green power LED (labelled PWR) should go on.

Step 4: Install the drivers:

Installing drivers for the Arduino Uno or Arduino Mega 2560 with Windows7, Vista, or XP

Step 5: Launch the Arduino application:

Double-click the Arduino application. (Note: if the Arduino software loads in the wrong language, you can change it in the preferences dialog. See the environment page for details.

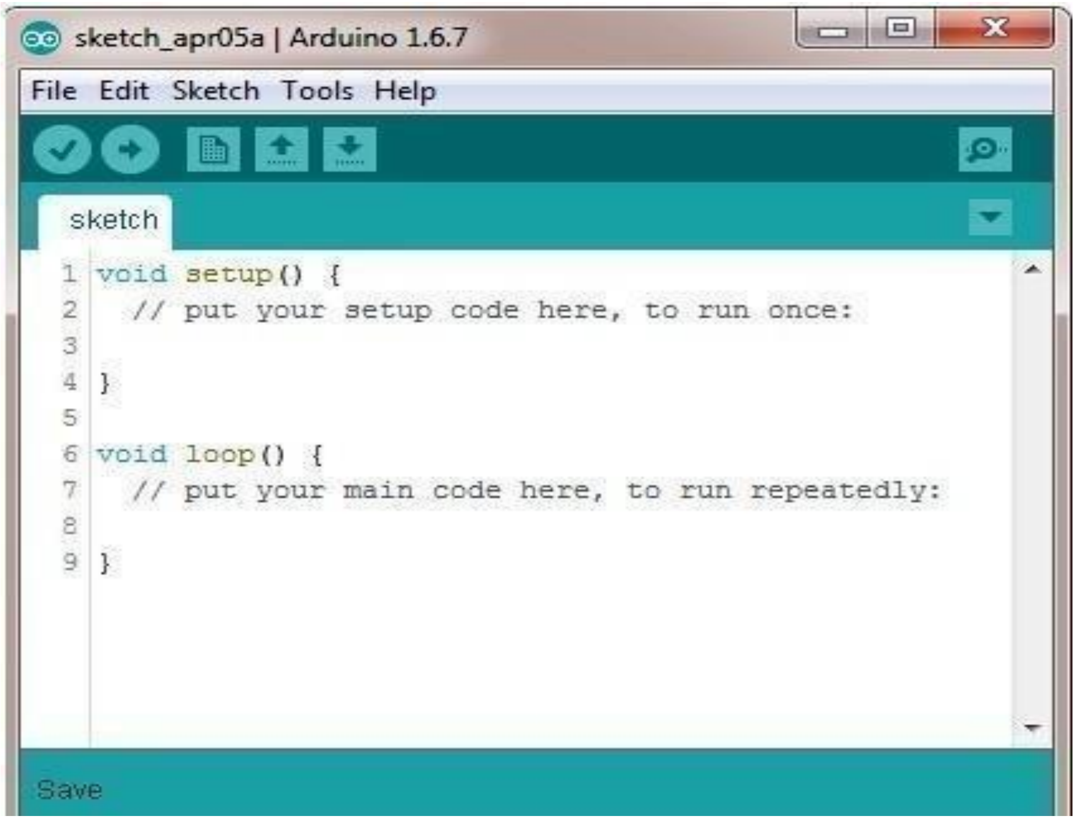

Fig13: Loading Arduino Software

Step 6: Open the blink example

Open the LED blink example sketch: File > Open > Temp_and_humid.ino

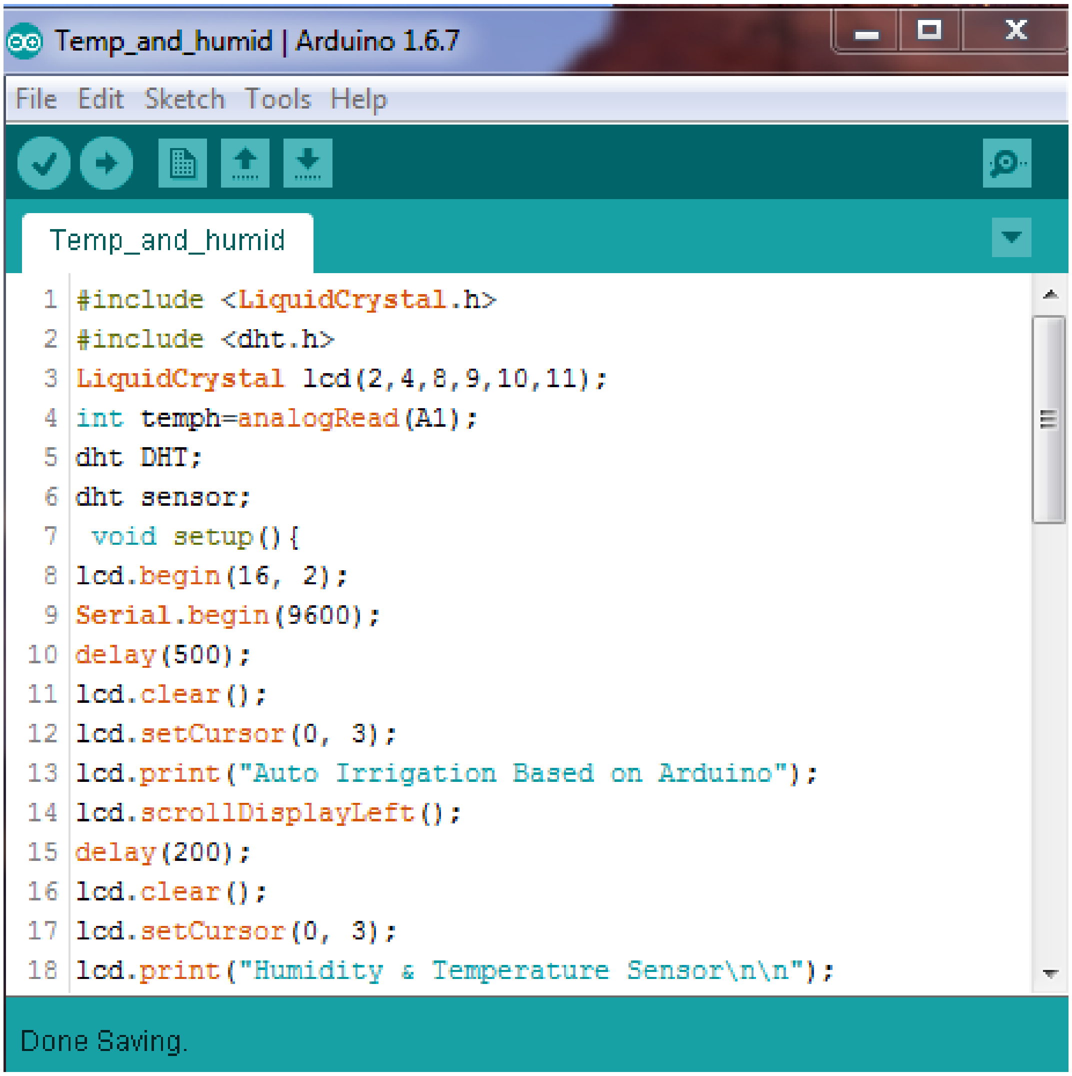

Fig14: LED blink learning system

Step 7: Select your board:

You'll need to select the entry in the Tools > Board menu that corresponds to your Arduino.

Step 8: Select your serial port:

Select the serial device of the Arduino board from the Tools | Serial Port menu. This is likely to be COM3 or higher (COM1and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu;

the entry that disappears should be the Arduino board. Reconnect the board and select that serial port.

Step 9: Upload the program:

Now, simply click the "Upload" button in the environment. Wait a few seconds - you should see the RX and TX leds on the board flashing. If the upload is successful, the message "Done uploading." will appear in the status bar.

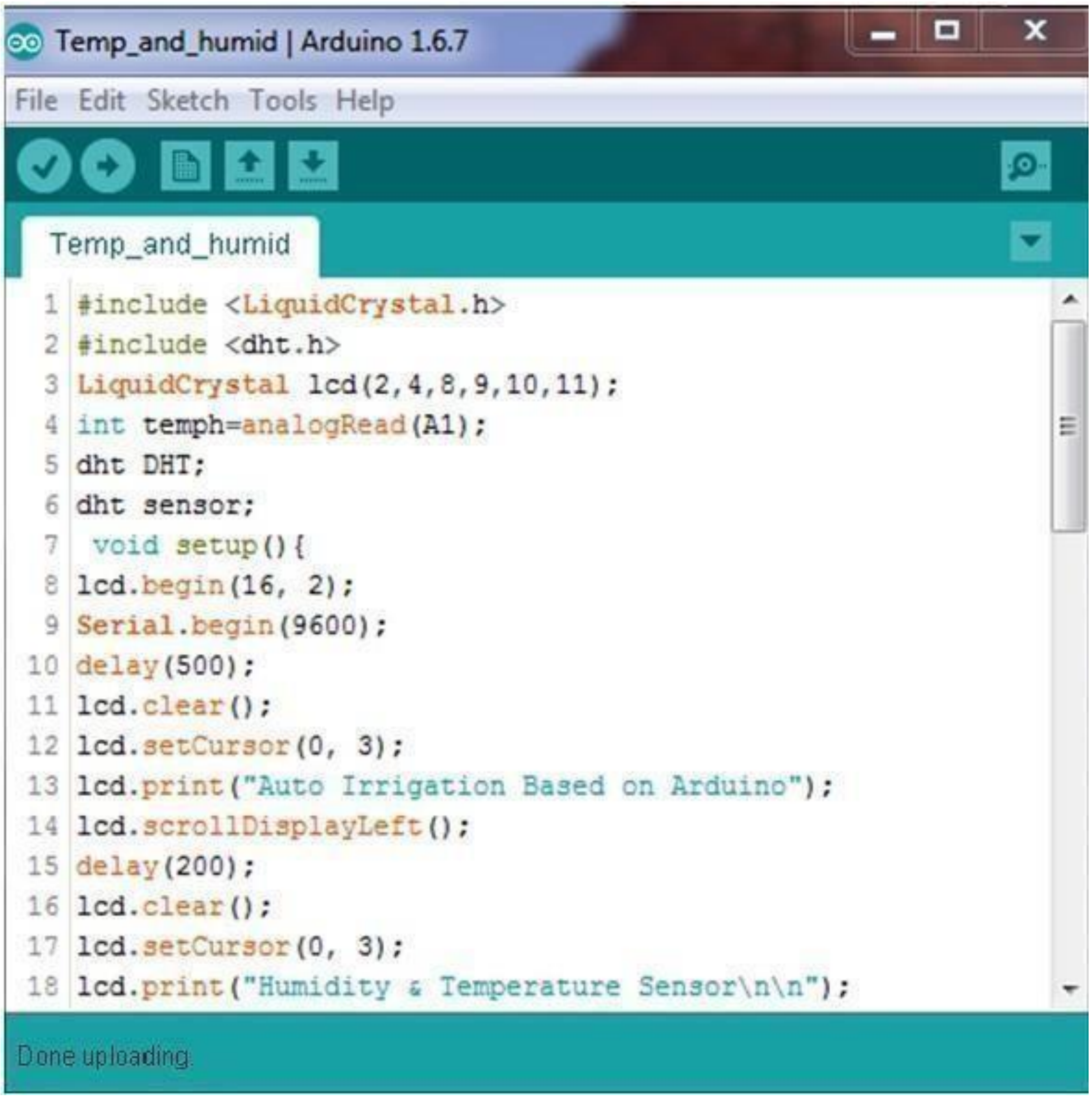

Fig15: Uploading the Program

III. Embedded C

Embedded C is a set of language extensions for the C Programming language. C is often used for system programming, including implementing applications. Embedded C uses most of the syntax of standard C, e.g., main() function, variable definition, data type declaration, conditional statements (if, switch, case), loops (while, for), functions, arrays and strings, structures etc.

It is small and simpler to learn, understand, program and debug. It is efficient & supports access to I/O and provides ease of management of large embedded projects.

The compiler derives its name from the way it works, looking at the entire piece of source code and collecting and reorganizing the instruction. See there is a bit little difference between compiler and an interpreter. Interpreter just interprets whole program at a time while compiler analyzes and execute each line of source code in succession, without looking at the entire program.

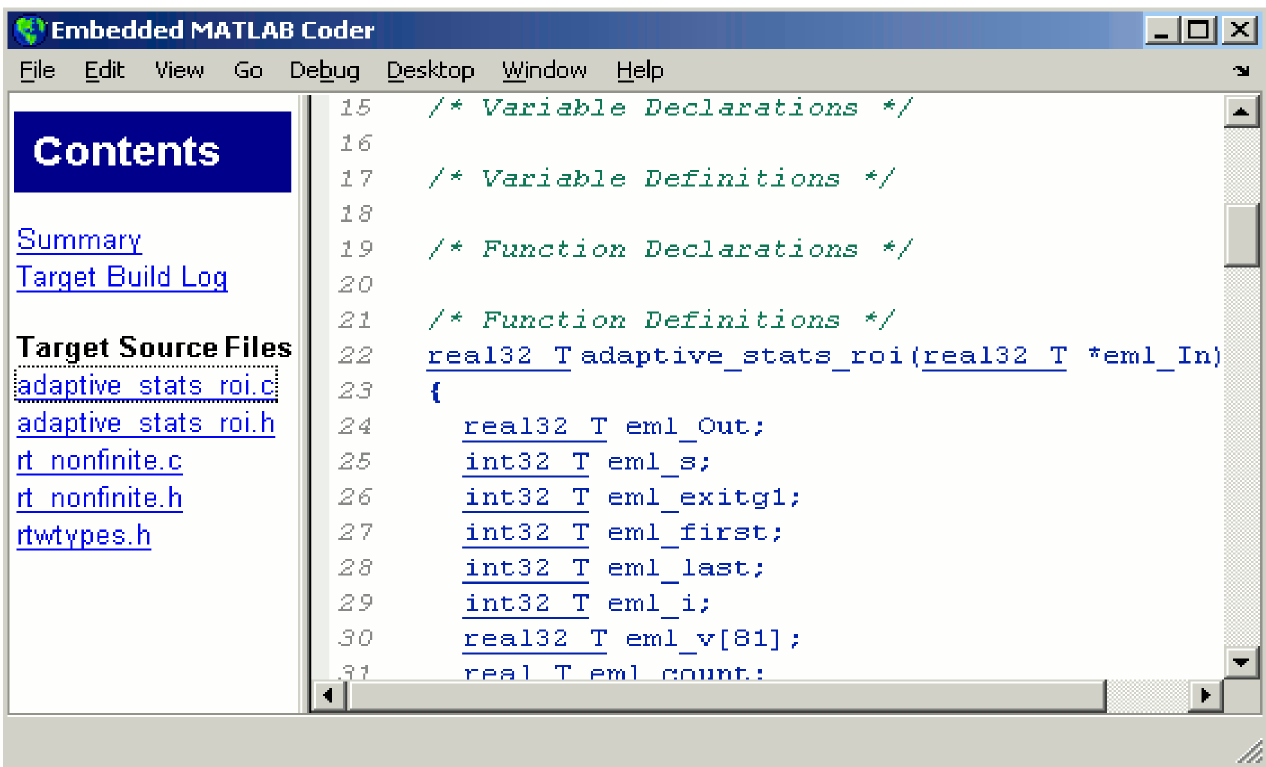

Fig16: Screen of Embedded MATLAB Coder using Embedded C Coding.

IV. Advantage of Embedded C

1) It is small and simpler to learn, understand, program and debug.
2) Compared to assembly language, C code written is more reliable and scalable, more portable between different platforms.
3) C compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers.
4) Unlike assembly, C has advantage of processor-independence and is not specific to any particular microprocessor/microcontroller or any system. This makes it convenient for a user to develop programs that can run on most of the systems.
5) As C combines functionality of assembly language and features of high-level languages, C is treated as a „middle-level computer language‟ or „high level assembly language‟.
6) It is fairly efficient.
7) It supports access to I/O and provides ease of management of large embedded projects.
8) Java is also used in many embedded systems but Java programs require the Java Virtual Machine (JVM), which consumes a lot of resources. Hence it is not used for smaller embedded devices.

7. Advantages

Relatively simple to design and install.

It is safest system and no manpower is required.

The system helps to farmer or gardener to work when irrigation is taking place, as only the area between the plants is wet.

Reduce soil erosion and nutrient leaching.

The system needs smaller water sources, as it consumes less than half of the water.Fertilizers can also be provided by using the system.

PH content of the soil is maintained Through the suggestions which helps for healthy plant growth.

8. Conclusion

The primary applications for this project are for farmers and gardeners who do not have enough time to water their crops/plants. It also covers those farmers who are wasteful of water during irrigation.

As water supplies become scarce and polluted, there is a need to irrigate more efficiently in order to minimize water use and chemical leaching. Recent advances in soil water sensing make the commercial use of this technology possible to automate irrigation management for vegetable production. However, research indicates that different sensors types perform under all conditions with no negative impact on crop yields with reductions in water use range as high as 70% compared to traditional practices.

9. Future Work

While this study has made significant contributions to the field of automatic irrigation using Arduino, there are several areas that warrant further investigation and development. The future work section outlines potential directions for future research, improvements, and enhancements to advance the field and address some of the limitations identified in this study.

1. Integration of Sensor Networks: This study focused on using a single sensor for soil moisture measurement. However, future work could explore the integration of multiple sensors, such as temperature, humidity, and light sensors, to provide a more comprehensive understanding of the soil and environmental conditions. This integration would enable more precise irrigation control and adaptive strategies based on real-time data.
2. Wireless Communication and Internet of Things (IoT): Currently, the irrigation system relies on a wired connection between the Arduino board and the sensor. Future work could investigate the use of wireless communication protocols, such as Zigbee or Wi-Fi, to establish a network of distributed sensors and actuators. Additionally, integrating the system with IoT platforms would allow for remote monitoring and control, enabling farmers to manage irrigation schedules and receive alerts on their mobile devices.
3. Advanced Control Algorithms: While this study implemented a basic control algorithm based on threshold values, future work could explore the application of advanced control algorithms. For example, model predictive control (MPC) or fuzzy logic algorithms could be employed to optimize irrigation decisions based on various factors, including historical data, weather forecasts, and plant-specific requirements. These advanced algorithms would enhance the system's ability to adapt to changing conditions and improve water use efficiency.
4. Energy Efficiency and Power Management: In this study, the Arduino board was powered by a constant power source. However, in practical agricultural scenarios, power availability might be limited. Future work could focus on developing energy-efficient strategies, such as power harvesting techniques using solar panels or implementing sleep modes for energy conservation, to ensure the system's sustainability and operation in remote or off-grid areas.
5. Integration with Crop Growth Models: To further optimize irrigation strategies, future work could explore the integration of crop growth models with the automatic irrigation system. By considering plant growth stages, phenology, and water requirements, the system could dynamically adjust irrigation schedules to ensure optimal crop health and yield. The incorporation of crop growth models would enhance the system's intelligence and provide valuable insights for farmers.
6. Field Testing and Validation: While this study conducted experiments in a controlled environment, future work should include extensive field testing to validate the system's performance under real-world conditions. Field trials would provide valuable insights into the system's reliability, robustness, and effectiveness in different soil types, crop varieties, and climatic conditions. Additionally, user feedback and evaluation should be obtained to ensure usability and practicality for farmers.

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- http://gardenbot.org/howTo/soilMoisture/