SMART IRRIGATION USING WEATHER PREDICTION

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Abstract

In agriculture the major problem which farmers face is the water scarcity, so to improve the usage of water one of the irrigation system using drip irrigation which is implemented is "Automated irrigation system with partition facility for effective irrigation of small scale farms" (AISPF).But this method has some drawbacks which can be improved and here we are with a method called "Automated irrigation system using weather prediction for efficient usage of water resources' (AISWP), it overcomes the drawback of AISPF process. AISWP method helps us to use the available water resources more efficiently by sensing the moisture present in the soil and apart from that it is actually predicting the weather by sensing atmospheric pressure i.e., barometric pressure (in inches). This system requires soil-moisture sensor, barometric pressure sensor, thereby processing the measured values through an algorithm and releasing the water accordingly which is an added feature of AISWP so that water can be efficiently used. Because of its energy efficiency and lowest cost, this automated system has to be useful in the areas where the ground water level is less.

Key words: *weather prediction, soil moisture sensor arduino mega*

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1. INTRODUCTION

Basically the soil needs some amount of moisture present in it. The soil actually holds some amount of moisture in its pores which is called as moisture holding capacity of the soil. The crop will be in critical stage when the moisture in the field is less than 50% of moisture holding capacity. Smart Irrigation Technology encompasses any irrigation technology that helps apply water to the landscape efficiently with quantified, documented water savings. Smart irrigation controllers have been in the forefront of the new smart irrigation technology. [1]A smart controller uses environmental information such as weather or soil moisture to adjust the landscape irrigation schedule for the changing environmental conditions Smart controllers use site-specific information to adjust landscape irrigations. Smart controllers use either soil moisture or weather data to make these adjustments, changing either the amount of time to run the irrigation system or the frequency of irrigation.[2] These changes reflect seasonal and short-term weather conditions and help prevent unnecessary irrigations. Climate -based smart controllers use weather information to adjust the controller settings, usually with on-site instrumentation that can include air temperature, humidity, wind, solar and/or rain sensors. Soil-moisture based controllers have a soil moisture sensor that is installed in the turf and connected directly to the controller. Soil moisture sensors monitor the changes in soil moisture as the turf extracts water or as irrigation or rainfall replenish the soil water.[3] Knowledge of soil water holding properties is very helpful in setting up, understanding, and effectively training these systems. Excessive sod disturbance and root damage will result in non-representative soil moisture readings. Close contact with the sensor is required, so air gaps from installation must be eliminated.[11] Soil Moisture-Based Controllers Soil moisture-based irrigation controllers use an on-site, buried soil moisture sensor to keep track of the available moisture status in the root zone. The main concern about effectiveness in the usage of water through irrigation is soil moisture handling capacity. Even though the field is irrigated, we can't tell about the level of soil moisture by checking it manually. To solve this problem we need technological tool called soil moisture sensor which is automated.

1.1 Components Required

ARDUINO MEGA: The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 It has 54 digital input/output pins (of which 14 can be used as PWM outputs),16 analog inputs, 4 UARTs(hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. [9]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.

COMMUNICATION

Soil moisture sensor

This sensor can be used to test the moisture of soil, when the soil is having water shortage, the module output is at high level, else the output is at low level. [4]By using this sensor one can automatically water the flower plant, or any other plants requiring automatic watering technique. System Calibration. To get any sort of useful data out of your Soil Moisture Sensor, it is advised that you calibrate it to whatever soil you plan to monitor. Different types of soil can affect the sensor, and you may get different readings from one composition to the next

Soil Calibration

Once you have an idea what values your sensor is outputting in completely dry and completely wet situations, it's time to calibrate your sensor for the specific soil you want to monitor.

LM393 Driver:
The hardware is consists of an Arduino microcontroller (here an Arduino Uno R3) and a pre-wired soil moisture sensor module.[12] The soil moisture sensor module, built around the LM393.

Comparator, gives an active-low (L) level output when the soil is dry (determined by a pre-settled threshold value). This digital output (wet soil → L / dry soil → H) is routed to one I/O terminal (D2) of the Arduino microcontroller [3]. Based on this input (at D2) arduino gives an active-high (H) output through D13 when soil is dry, and an active-low (L) output when soil is wet.

Calculating pressure at sea level: With the measured pressure p and the absolute altitude the pressure at sea level can be calculated Thus, a difference in altitude of Δaltitude = 10m corresponds to 1.2hPa pressure change at sea level. Calculating absolute altitude: With the measured pressure p and the pressure at sea level p0 e.g. 1013.25hPa, the altitude in meters can be calculated with the international barometric formula Thus, a pressure change of Δp = 1hPa corresponds to 8.43m at sea level.

Mini DC Brushless Water Pump

This mini pump is a submerged pump just put it in the water to pump. Suitable for bird bath, fish tank, small pond, garden decoration, water circulation for oxygen or etc.
The importance of low cost and high reliability to the successful deployment of electrical accessories in future vehicles cannot be overstated. Careful attention to system optimization including the machine, converter, and load will always pay dividends in the development of new equipment. Electric water pumps offer several advantages. Among them, the efficiency is the main reason for electric water pumps.[5]Conventional mechanical water pump is directly connected by the engine belt. For this reason, regardless of coolant circulation, the conventional mechanical water pump is always operated.

The way which the mechanical water pump is replaced by electric water pump could reduce energy consumption. Besides, electric vehicle (EV) do not have the internal combustion engine.

1.2 Weather Prediction using barometer

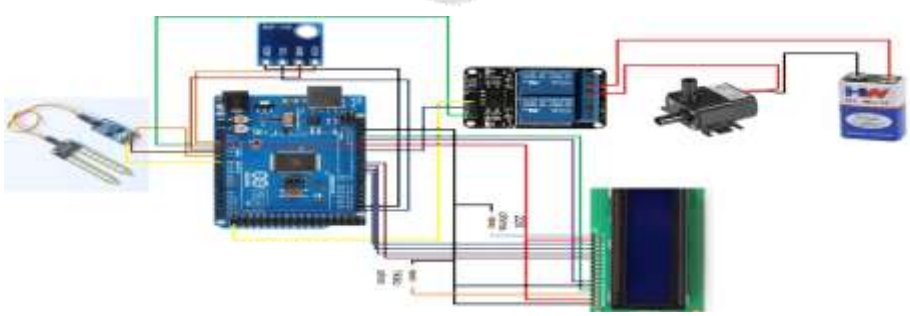
Weather Prediction using barometer involves 4 stages.
Stage 1: SETTING A BAROMETER
STAGE 2: USING A BAROMETER
STAGE 3: FORECASTING THE WEATHER
STAGE 4: CALCULATING ALTITUDE USING BAROMETER
To calculate the atmospheric pressure, we use BMP180 sensor. The conditions for prediction of
The above table tells us the condition of upcoming weather condition based on the present value of atmospheric pressure and the rate of change of atmospheric pressure.
Rapidly- change of greater than 0.1 inches of mercury.
Slowly- change of less than 0.1 inches of mercury.
The below table shows the model of prediction of weather

MP reading	$(n-2)^{nd}$ hour read	$-1)^{th}$ hour reading	hour reading
hange of BMP reading			
nal BMP change	verage of 1,2,3		

n^{th} hour reading- The present hour reading of barometric pressure sensor in inches of mercury.$(n-1)^{th}$ hour reading- The past hour reading of barometric pressure sensor of n^{th} hour in inches of mercury.$(n-2)^{th}$ hour reading- The past hour reading of barometric pressure sensor of $(n-1)^{th}$ hour in inches of mercury.1= $(n-3)^{rd}$ hour reading – $(n-2)^{nd}$ hour reading 2= $(n-2)^{nd}$ hour reading – $(n-1)^{th}$ hour reading3= $(n-1)^{th}$ hour reading – $(n)^{th}$ hour reading For the function of the conditions in Table 1, we need n^{th} hour(present value of atmospheric pressure in inches of mercury) data and the average of 1,2,3 values (rate of change of atmospheric pressure values).

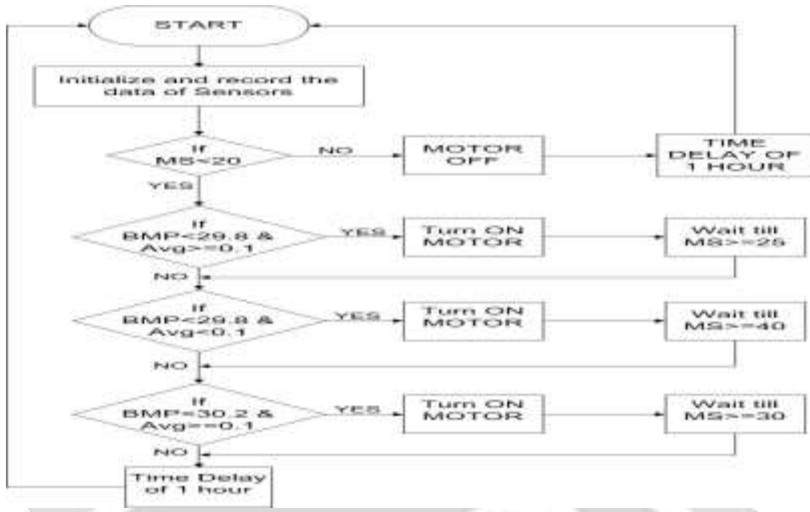
2. WORKING PRINCIPLE

For the working of the circuit, firstly we need to interface all the harware components to the Arduino. The power for working of the components except motor, is given from Arduino Mega through 5V pin, 3.3V pin,Vin(3.3V) and GND. The Arduino is powered through USB cable. Soil Moisture Sensor and BMP180 serve as input. Relay, Motor and LCD Display serve as output.



Schematic diagram

2.1 The below flow chart shows the working



Working

Step1- Connections are given as per the circuit diagram

Step2- Initialize and record the data of sensors

Step3- Check moisture sensor level. If moisture sensor level is more than threshold value, then the motor is set to be in OFF position.

Step4- If moisture sensor value is less than threshold value, then it will check the BMP sensor present reading and final BMP change value.

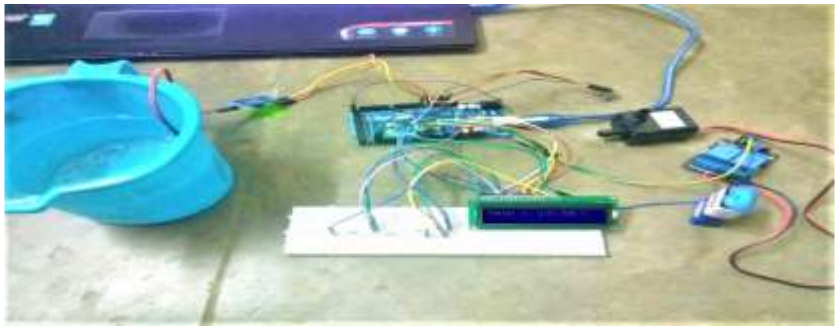
If BMP present value <= 29.8 and final BMP change >=0.1 then the motor is set to operate until moisture sensor value >= 25 because rain is predicted to fall in few hours.If BMP present value <= 29.8 and final BMP change <=0.1 then the motor is set to operate until moisture sensor value >= 40 because rain is predicted to fall within 48 hours.

If BMP present value <= 30.2 and final BMP change >=0.1 then the motor is set to operate until moisture sensor value >= 30 because rain is predicted to fall within 24 hours.

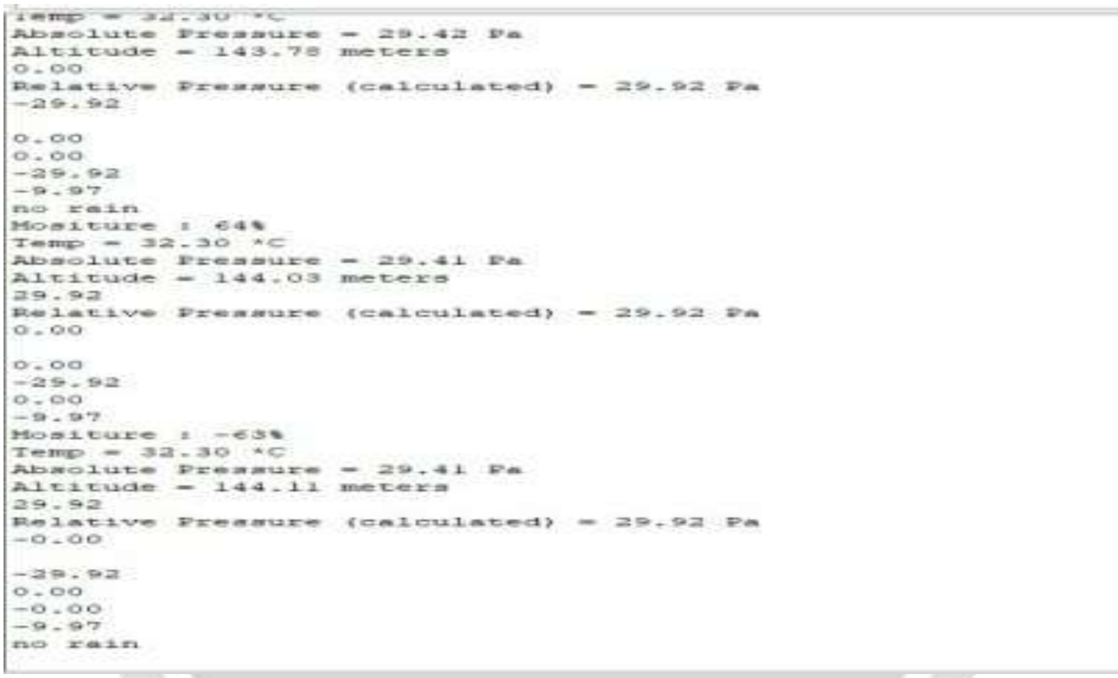
Step5- After any of the above three operations is performed, a delay of 1 hour is set so that the whole process will be repeated for every hour.

RESULTS AND DISCUSSIONS

The results of this project are shown in the form of output from the serial monitor in the Aurduino software. The serial monitor prints the data which was commanded in the code to print in the serial monitor. The experimental setup of this project is also shown so that the interfacing and the connections can be visualized.



Results in Serial Monitor



```
Temp = 32.30 *C
Absolute Pressure = 29.42 Pa
Altitude = 143.78 meters
0.00
Relative Pressure (calculated) = 29.92 Pa
-29.92

0.00
0.00
-29.92
-9.97
no rain
Mositure : 64%
Temp = 32.30 *C
Absolute Pressure = 29.41 Pa
Altitude = 144.03 meters
29.92
Relative Pressure (calculated) = 29.92 Pa
0.00

0.00
-29.92
0.00
-9.97
Mositure : -63%
Temp = 32.30 *C
Absolute Pressure = 29.41 Pa
Altitude = 144.11 meters
29.92
Relative Pressure (calculated) = 29.92 Pa
-0.00

-29.92
0.00
-0.00
-9.97
no rain
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Result in Serial Monitor

The serial monitor prints the data of moisture, temperature, absolute pressure, altitude, relative pressure and BMP change of past three hours and the final BMP change. It will also print the predicted weather if any one of the condition is satisfied.

Future Expansion

For small fields and prototype projects a single soil moisture sensor is sufficient. But for large field if we use only a single sensor, the main objective of this project i.e. water conservation, cannot be accomplished due to the fact that land is not uniform all over the field. [6]Due to that even though the water from the pump is sufficient, the moisture sensor may not sense that.So for large fields partition of field should be done and moisture sensors will be placed in each part of the field. Pipes that provide water to the field will be tapped nearer to the each soil moisture sensor with a solenoid valve. So when any sensor reads less moisture, the respective solenoid valve will get opened and water will be provided in that part of field[8].

Even though atmospheric pressure is a good parameter to predict weather, we can also use parameters like air temperature, wind direction, wind speed, humidity for more accuracy in the prediction of weather. Conventional Irrigation methods like canal irrigation leads to heavy wastage of water. So modern irrigation methods like Drip Irrigation, Sprinkler Irrigation must be used for effective usage of water.

CONCLUSION

In addition to the above mentioned ideas, a small research on soil moisture, different types of soils, amount of water required for different soils, variety of of crops, suitability of crops with respect to season and soil, amount of water required for different soils. This can give you an idea about the amount water and moisture required with respect to soil and crop.

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