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Analysis of Soil Properties by Multi Sensor Technique

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***Abstract*:- Agriculture contributes to a major portion of India's GDP. Two major issues in modern agriculture are water scarcity and high labor costs. These issues can be resolved using agriculture task automation, which encourages precision agriculture. Considering abundance of sunlight in India, this paper discusses the design and development of an IoT Agribot that automates irrigation task and enables remote farm monitoring. The Agribot is developed using a PIC microcontroller. While executing the task of irrigation, it moves along a pre-determined path of a given farm, and senses soil moisture content and temperature at regular points. At each sensing point, data acquired from multiple sensors is processed locally to decide the necessity of irrigation and accordingly farm is watered. Further, Agribot acts as an IoT device and transmits the data collected from multiple sensors to a remote server using GPS/GPRS. At the remote server, raw data is processed using signal processing operations such as filtering, compression and prediction. Accordingly, the analyzed data statistics are displayed using an interactive interface, as per user request.**

Key Words: Microprocessor, Microcontroller, Turbidity, Humidity, pH and Temperature.

INTRODUCTION:

According to the recent statistics, the land used for crop cultivation in India is decreasing at an accelerating rate. Outdated irrigation techniques and availability of water resources are the primary reasons for incoherent production. Hence, technological solutions for agriculture task automation are the need of the hour. In particular, simplified irrigation mechanisms reducing water wastage are very essential, which encourage precision agriculture. Technological solutions for irrigation and agricultural task automation are driven by electric power. Hence technological solutions for agriculture task automation can yield better benefits for Indian environmental conditions.

BASICS AND CLASSIFICATION OF EMBEDDED SYSTEMS

❖ Classification of Embedded Systems

Embedded systems are often required to provide ***Real-Time response***. A ***Real-Time system*** is defined as a system whose correctness depends on the timeliness of its response. Examples of such systems are flight control systems of an aircraft, sensor systems in nuclear reactors and power plants.

For these systems, delay in response is a fatal error. A more relaxed version of ***Real-Time Systems*** is the one where timely response with small delays is acceptable. Example of such a system would be the Scheduling Display System on the railway platforms. In technical terminology, ***Real-Time Systems*** can be classified as:

- ***Hard Real-Time Systems*** - systems with severe constraints on the timeliness of the response.
- ***Soft Real-Time Systems*** - systems which tolerate small variations in response times.
- ***Hybrid Real-Time Systems*** - systems which exhibit both hard and soft constraints on its performance.

❖ **What is a Microprocessor?**

- A Microprocessor is an integrated circuit capable of performing arithmetic and logical operations, such as add, subtract, compare, logical AND & OR functions.
- when combined with other integrated circuits such as memory, timer, and peripheral interface chips, the microprocessor becomes a computer.
- The Microprocessor performs the arithmetic and logical operations using sequence of instructions.

❖ **What is a Microcontroller?**

A microcontroller is a computer-on-a-chip, or a single-chip computer. Micro suggests that the device is small, and controller tells that the device might be used to control objects, processes, or events. Another term to describe a microcontroller is embedded controller, because the microcontroller and its support circuits are often built into, or embedded in, the devices they control.

❖ **Literature Review**

[1] Kalyan et al (2011): The need for systems that make agriculture easier and more sustainable has increased within the past few years.

[2] Priyanka et al (2012): involves some sensors, LCD display, and GSM and ARM processor.

[3] Anjum Awasthi et al, (2013): The proposed system in this paper is designed by considering the requirement of a sugarcane crop for Indian climatic conditions.

[4] Sanjukumar et. al. (2013): The Soil moisture content based irrigation system was developed and successfully implemented along with flow sensor.

[5] Swarup et al (2013) : Smart sensors based monitoring system for agriculture have been used to increase the yield of plants by monitoring the environmental conditions (parameters) and thus providing the necessary information to the clients (farmers). The proposed system is mainly developed for the betterment of farmers.

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[6] Saleemmaleekh et el (2013) : With the advancement in technology, the world around us in every part of our life getting automated.

[7] Fredlund & Xing (1994) listed the various works carried out to derive equations for the soil-water characteristic curve.

[8] Measuring water content in soils is an important task and many authors have suggested and attempted several innovative, cost-effective and time saving approaches.

[9] Sun et al (2008) developed a multi-sensor system, which consists of a cell with three sensors for measuring soil water content, mechanical strength and Electrical Conductivity (EC).

[10] Zhao et al (2009) developed an artificial neural network (ANN) model to predict soil texture (sand, clay and silt contents) based on soil attributes obtained from existing coarse resolution soil maps combined with hydrographic parameters derived from a digital elevation model (DEM) of the Black Brook Watershed (BBW) in northwestern New Brunswick, Canada.

1. Turbidity Sensor

❖ **General Description**

TCS3200 Color Recognition Sensor is a small module designed with TCS3200 Color Sensor that can convert light intensity to frequency. The TCS3200 can detect and measure a nearly limitless range of visible colors. The TCS3200 has an array of photo detectors, each with either a red, green, or blue filter or no filter.
The filters of each color are distributed evenly throughout the array to eliminate location bias among the colors. Internal to the device is an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen color.

TURBIDITY SENSOR

❖ **Features**

- Supply voltage: (2.7v-5.5v) DC
- Programmable color and full-scale output frequency
- Power down feature
- Compact design

❖ **Applications**

- Test strip reading
- Sorting by color
- Color matching
- LED and LCD backlighting

1. Humidity Sensor

❖ **General Description**

Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapor also influences various physical, chemical, and biological processes. Humidity measurement in industries is critical because it may affect the business cost of the product and the health and safety of the personnel. Hence, **humidity sensing** is very important, especially in the control systems for industrial processes and human comfort.

Humidity Sensor

3. pH Sensor

❖ **General Description**

Use the pH Sensor just as you would a traditional pH meter with the additional advantages of automated data collection, graphing, and data analysis. Typical activities using our pH sensor include; Acid-base titrations, Studies of household acids and bases, Monitoring pH change during chemical reactions or in an aquarium as a result of photosynthesis, Investigations of acid rain and buffering, Analysis of water quality in streams and lakes

pH Sensor

❖ **Features**

- Supply voltage: 5VDC
- Soil Tester Moisture - Light - PH
- Output: Analog

❖ **Applicatons**

- Acid-base titrations
- Analysis of water quality in streams and lakes

4. Temperature Sensor

❖ **LM35 Precision Centigrade Temperature Sensors**

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

❖ 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. Low cost is assured by trimming and

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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. It can be used with single power supplies, or with plus and minus supplies.

❖ **Features**

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±1⁄4°C typical
- Low impedance output, 0.1 W for 1 mA load

5. Soil Moisture Sensor

❖ **General Description**

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, and else the output is at low level. By using this sensor one can automatically water the flower plant, or any other plants requiring automatic watering technique.
Module dual output mode, digital output is simple, analog output more accurate.
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.

❖ **Features**

- Input voltage: 5v
- Output voltage:0-5v
- Output: Analog.
- Sensitivity adjustable.
- Threshold level can be configured.
- Module triple output mode, digital, analog, serial outputs.

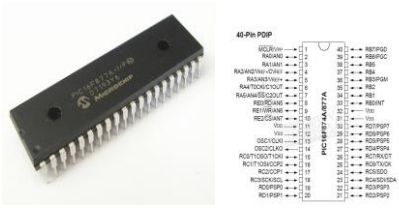
❖ **Applications**

- Agriculture.
- Landscape irrigation.
- Research
- Simple sensor for Gardeners.

6. PIC16F877A

High-Performance RISC CPU:

• Only 35 single-word instructions to learn
• All single-cycle instructions except for program branches, which are two-cycle
• Operating speed: DC – 20 MHz clock input DC – 200 ns instruction cycle
• Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
• Pinot compatible to other 28-pin or 40/44-pin PIC16CXXX and PIC16FXXX microcontrollers



LCD

7. LCD Character 2 x 16

The Liquid Crystal Display (LCD) was first developed at RCA around 1971. LCDs are optically passive displays (they do not produce light). As a result, LCDs require all most no power to operate. Many LCD calculators can operate from the power of a solar cell, others can operate for years from small button cell batteries. LCDs work from the ability of liquid crystals (LC) to rotate polarized light relative to a pair of crossed polarizers laminated to the outside of the display. There are two main types of LCD displays used for calculators today: Twisted nematic (TN) and supertwisted nematic (STN). TN displays twist polarized light to 90 degrees and have a limited viewing angle. STN displays were developed to twist polarized light between 180 to 260 degrees resulting in better contrast and a wider viewing angle.

LCD Character 2x16 Module

8. Transformer

❖ **General Description:**

It is a general purpose chassis mounting mains transformer. Transformer has 240V primary windings and center tapped secondary winding. The transformer has flying colored insulated connecting leads (Approx. 100 mm long). The Transformer act as step down transformer reducing AC - 240V to AC - 12V. Power supplies for all kinds of project & circuit boards. Step down 230 V AC to 12V with a maximum of 500mAmp current. In AC circuits, AC voltage, current and waveform can be transformed with the help of Transformers. Transformer plays an important role in electronic equipment. AC and DC voltage in Power supply equipment are almost achieved by transformer's transformation and commutation.

TRANSFORMER

Features

- Output current:500mA
- Supply voltage: 220-230VAC
- Output voltage: 12VAC

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- Soft Iron Core
- 500mAmp Current Drain

9. LM7805

❖ **General Description**

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

❖ **Features**

- Output Current up to 1A
- Output Voltages of 5v
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

LM7805

❖ **Software Description**

1. MPLAB

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and dsPIC microcontrollers, and is developed by Microchip Technology. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit PIC and AVR (including ATMEGA) microcontrollers, 16-bit PIC24 and dsPIC microcontrollers, as well as 32-bit SAM (ARM) and PIC32 (MIPS) microcontrollers.

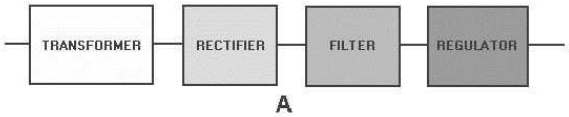
MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PICK it programmers are also supported by MPLAB.

2. Embedded C

Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces and basic I/O hardware addressing. Embedded C uses most of the syntax and semantics 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 and union, bit operations, macros, etc.

❖ **Power Supply**

A **power supply** (sometimes known as a **power supply unit** or **PSU**) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.



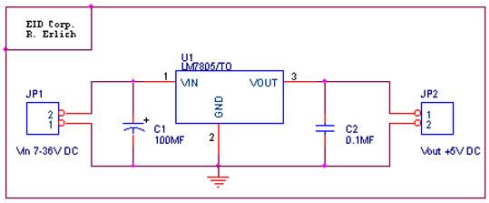
A

Block diagram of a basic power supply.

CIRCUIT DESCRIPTION

This circuit is a small +5V power supply, which is useful when experimenting with digital electronics. Small inexpensive wall transformers with variable output voltage are available from any electronics shop and supermarket. Those transformers are easily available, but usually their voltage regulation is very poor, which makes then not very usable for digital circuit experimenter unless a better regulation can be achieved in some way. The following circuit is the answer to the problem.

This circuit can give +5V output at about 150 mA current, but it can be increased to 1 A when good cooling is added to 7805 regulator chip. The circuit has over overload and therminal protection.



Circuit diagram of the Power Supply.

The capacitors must have enough high voltage rating to safely handle the input voltage feed to circuit. The circuit is very easy to build for example into a piece of Vero board.

Pinot of the 7805 regulator IC.

- 1. Unregulated voltage in
- 2. Ground
- 3. Regulated voltage out

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Component List*:*

7805 regulator IC
100 uF electrolytic capacitor, at least 25V voltage rating
10 uF electrolytic capacitor, at least 6V voltage rating
100 nF ceramic or polyester capacitor

CONCLUSION

Here by we conclude that all the five Soil Properties (Temperature, pH, Turbidity, Humidity, and Soil Moisture) has been analyzed at five different places through IOT and readings are presented in line graph along with date and time has been uploaded to the website precisely. Therefore we can find the values at the place where the experiment is conducted.

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RESULTS

ANALYSIS OF SOIL PROPERTIES BY USING MULTI SENSOR TECHNIQUE (IOT

S.No	Date	pH	SOIL MOISTURE	TEMPERATURE	TURBIDITY	HUMIDITY
1	2019/03/15 03:23:24am	100	100	100	100	100
2	2019/03/15 03:27:25am	100	100	100	100	100
3	2019/03/15 03:31:51am	0000	0000	0064	0024	0015
4	2019/03/15 03:32:24am	0000	0000	0064	0011	0012
5	2019/03/15 03:32:58am	0000	0000	0064	0000	0015
6	2019/03/15 03:33:31am	0000	0407	0065	0011	0013
7	2019/03/15 03:34:05am	0000	0000	0065	0028	0014
8	2019/03/15 01:00:39pm	0000	0000	0067	0448	0396
9	2019/03/15 01:01:12pm	0000	0000	0067	0446	0391
10	2019/03/15 01:01:47pm	0000	0000	0067	0412	0373
11	2019/03/15 01:02:19pm	0000	0000	0067	0462	0402
12	2019/03/15 01:02:54pm	0000	0000	0066	0419	0387
13	2019/03/15 01:03:25pm	0000	0000	0066	0417	0387
14	2019/03/15 01:03:59pm	0000	0166	0067	0373	0354
15	2019/03/15 01:04:32pm	0000	0000	0067	0405	0379

ANALYSIS OF SOIL PROPERTIES BY MULTI SENSOR TECHNIQUE (IOT)

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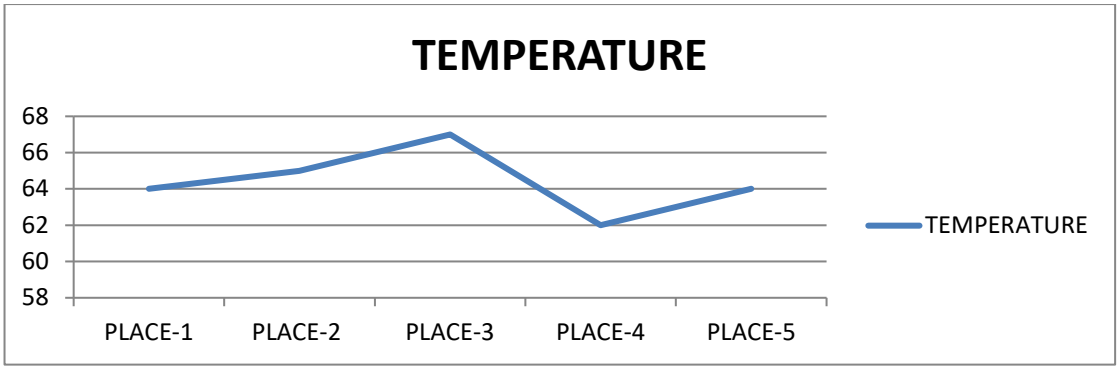

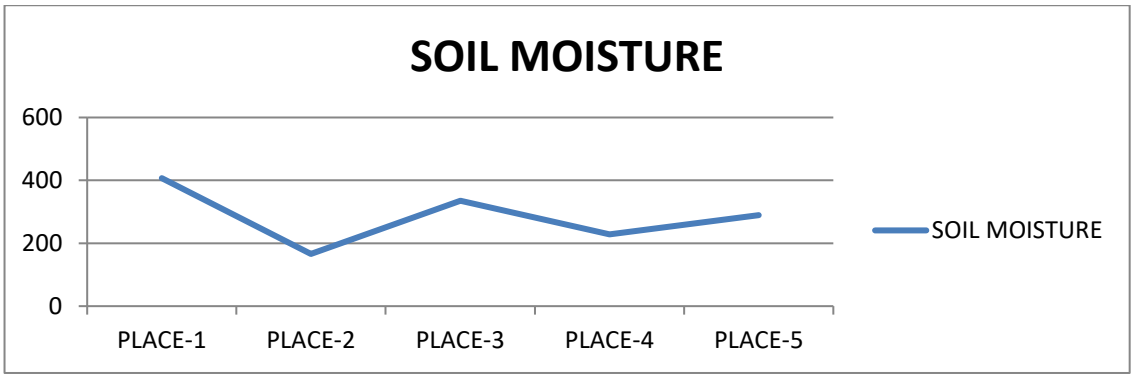

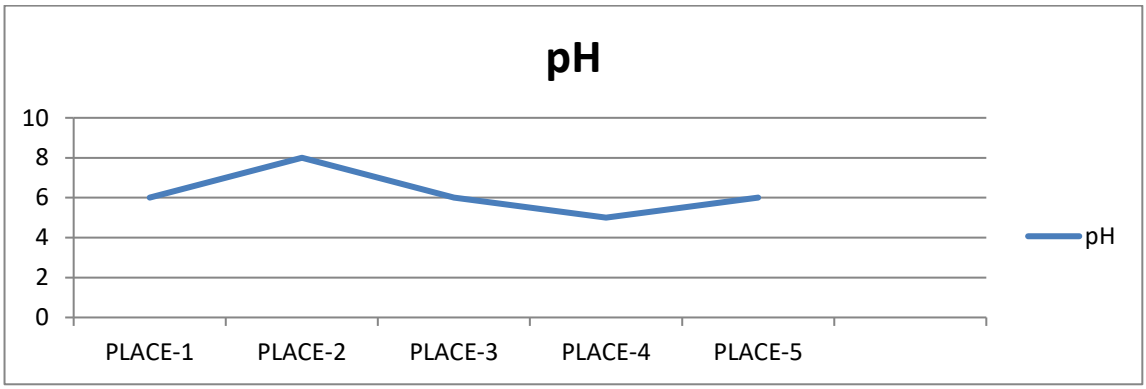

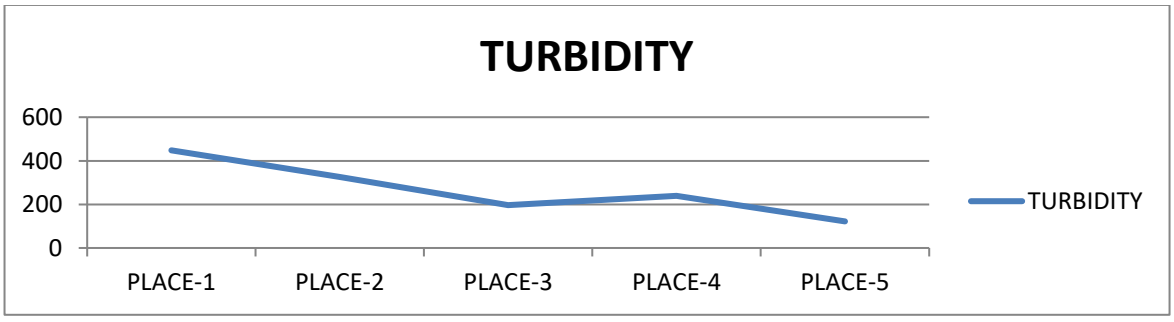

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