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# Soil Monitoring and Crop Identification Using IOT

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***Abstract***—Agriculture is the backbone of our country that contributes to 45% of the GDP that is responsible for the enhancement of country's economy. Our project aims on building an integrated module for improving the efficiency of the present agricultural modules. The proposed module consists of a series of array of sensors such as ambient temperature, moisture, air quality and the pH sensor to measure these parameters of the soil. All this data are sent to the cloud for backend works such as comparing it with the stored data and predicting the type of crop that can be grown after disaster for relief works by the government and insurance agents. This would considerably reduce the need of experts to visit the place and to perform manual testing during disaster.

***Keywords****-Agriculture, sensors, cloud , Soil .*

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## I. Introduction

IoT devices are expected to have a significant impact on farming and gardening while meeting the increasing consumption needs of a global population that is estimated to increase by 70% by 2050. Companies are working to build and sell new smart agriculture IoT devices and farmers capitalize on the opportunities IoT devices bring to increase their efficiency and create/sustain a leadership role in the market. Although the IoT technologies are expanding, there is currently no off-the-shelf product that enables farmers to monitor remotely multiple properties of the soil in real time.

The objective to gather data from pH, humidity and temperature sensors at regular intervals with a microcontroller. Our device is able to send soil data to a server on the internet and in return to receive commands. It operates autonomously, polling the sensors attached and periodically pushing the sensor readings wirelessly to the database residing on the cloud. On the cloud, a server side application crunches the stored values to provide a customized feedback tailored to each user via a web application.

We used a Wi-Fi wireless protocol for our device's networking stack, since it has the benefits of having a high bandwidth and transmission rate and being highly cost-effective.

## II. Existing System

There are many device available in the market today that allow farmers to monitor the soil on a regular basis from the comfort of their home. These devices are having a huge impact on crop production costs as they are reducing the time and resources of farmers and facilities required for farming. Farmers can monitor the soil regularly and irrigate the soil by the required amount of water. Farmers can access this information from their mobiles via wireless network and can check the soil's moisture content and also other parameters. The project aims in designing a system which is capable of monitoring of pH, humidity, soil temperature and light intensity alerts in case of emergency through SMS to predefined database.

## III. Proposed System

In the proposed system it is going to be focused on monitoring the soil and predicting the crop to be planted in the soil. By using the existing method the soils pH rate, temperature, light intensity, humidity, and atmospheric temperature can be monitored using the wireless sensors. We can monitor the soil's pH rate, temperature and humidity regularly. The monitored report of the land can access this information from their mobiles via wireless network and can check the soil parameters at any time. If they notice abnormalities, they can immediately notice the land and can make steps to overcome the abnormalities. This project aims in designing a system which is capable of tracking the soil parameters and suggesting which crop can be planted in the soil.

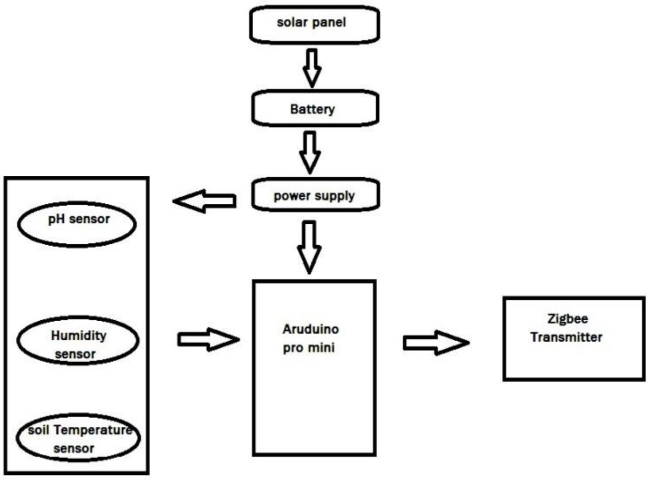


Figure 1: Transmitter

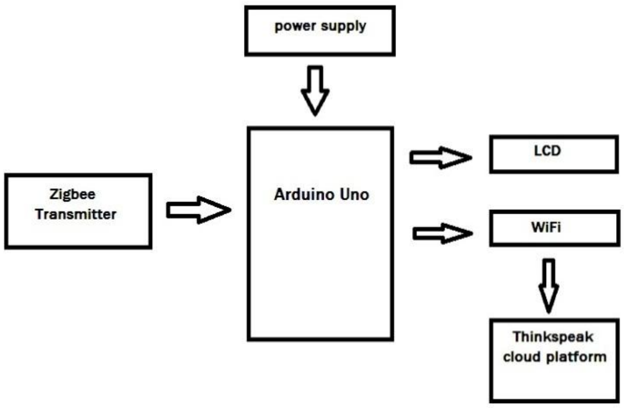


Figure 2: Receiver

**ESP8266X**

ESP8266EX delivers highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design and reliable performance in the Internet of Things industry.

With the complete and self-contained Wi-Fi networking capabilities, ESP8266EX can perform either as a standalone application or as the slave to a host MCU. When ESP8266EX hosts the application, it promptly boots up from the flash. The integrated high- speed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any micro-controller design as a Wi-Fi adaptor through SPI / SDIO or I2C / UART interfaces.


Figure 3:ESP8266EX

**2.4 GHz Receiver**
The 2.4 GHz receiver down-converts the RF signals to quadrature baseband signals and converts them to the digital domain with 2 high resolution high speed ADCs. To adapt to varying signal channel conditions, RF filters, automatic gain control (AGC), DC offset cancelation circuits and baseband filters are integrated within ESP8266EX.

**2.4 GHz Transmitter**
The 2.4 GHz transmitter up-converts the quadrature baseband signals to 2.4 GHz, and drives the antenna with a high-power CMOS power amplifier. The function of digital calibration further improves the linearity of the power amplifier, enabling a state of art performance of delivering +19.5 dBm average power for 802.11b transmission and +16 dBm for 802.11n transmission.

**Clock Generator**
The clock generator generates quadrature 2.4 GHz clock signals for the receiver and transmitter. All components of the clock generator are integrated on the chip, including all inductors, reactors, filters, regulators and dividers.

The clock generator has built-in calibration and self-test circuits. Quadrature clock phases and phase noise are optimized on-chip with patented calibration algorithms to ensure the best performance of the receiver and transmitter.

**Wi-Fi**
ESP8266EX implements TCP/IP, the full 802.11 b/g/n/e/i WLAN MAC protocol and Wi-Fi Direct specification. It supports not only basic service set (BSS) operations under the distributed control function (DCF) but also P2P group operation compliant with the latest Wi-Fi P2P protocol. Low level protocol functions are handled automatically by ESP8266EX.

**I2C Interface**
ESP8266EX has one I2C used to connect with micro-controller and other peripheral equipment's such as sensors.Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized via software programming, and the clock frequency is 100 kHz at a

maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

**I2S Interface**

ESP8266EX has one I2S data input interface and one I2S data output interface. I2S interfaces are mainly used in applications such as data collection, processing, and transmission of audio data, as well as the input and output of serial data. For example, LED lights (WS2812 series) are supported. I2S functionality can be enabled via software programming by using multiplexed GPIOs, and linked list DMA is supported.

**LED Light and Button**

ESP8266EX features 17 GPIOs, all of which can be assigned to support various functions of LED lights and buttons. Definitions of some GPIOs that are assigned with certain functions in demo application design. Altogether three interfaces have been defined; one is for the button, while the other two are for LED light. Generally, MTCK is used for controlling the reset button; GPIO0 is used as an signal to indicate the Wi-Fi working state; MTDI is used as a signal light to indicate communication status between the device and the server.

**Arduino Uno**

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

Figure 4: Arduino Uno

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 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.

**ARDUINO PRO MINI**

The Arduino Pro Mini is an ATmega168 based microcontroller board. The board comes with built-in Arduino boot loader. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 8 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. The board can be connected to the PC using USB port and the board can runs on USB power.

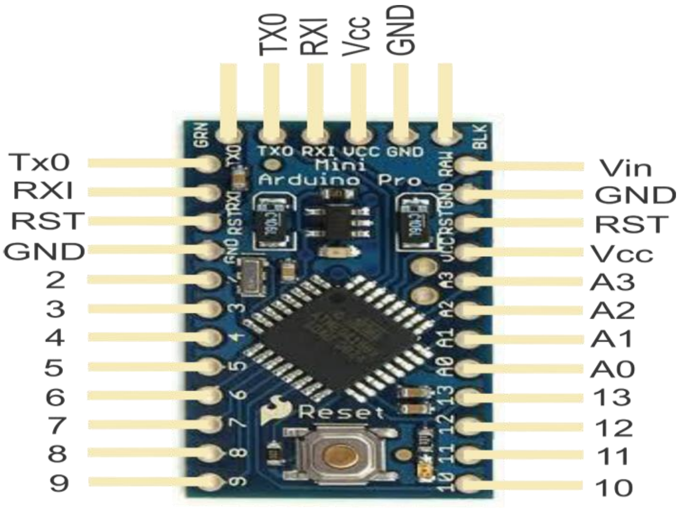


Figure 5: Arduino Pro Mini

**Temperature Sensor**

A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of environmental temperature.

In the temperature functional module we developed, we use the LM34 series of temperature sensors. The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration or trimming to provide typical accuracies of ±1.2°F at room temperature and ±11.2°F over a full -50 to +300°F temperature range. The LM34 is rated to operate over a -50° to +300°F temperature range.

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**Photo resistor**

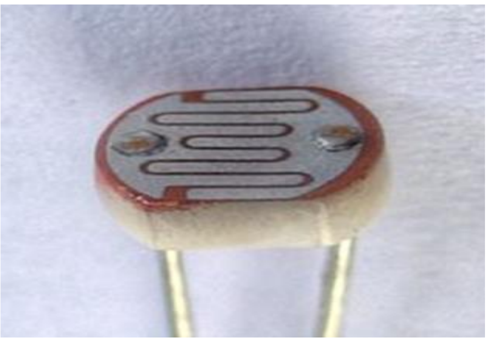

Figure 6: LDR

A photoresistor or light-dependent resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. A photo resistor is made of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as a few mega ohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photo resistors may react substantially differently to photons within certain wavelength bands.

**pH SENSOR**

A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as ph. The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution. The pH meter is used in many applications ranging from laboratory experimentation to quality control.

**Humidity Sensor**

DHT22 capacitive humidity sensing digital temperature and humidity module is one that contains the compound has been calibrated digital signal output of the temperature and humidity sensors. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. The sensor includes a capacitive sensor wet components and a high-precision temperature measurement devices, and connected with a high-performance 8-bit microcontroller. The product has excellent quality, fast response, strong anti-jamming capability, and high cost.

**Solar Panel**

Figure 7:Solar panel

**Battery**

Calculating how long a battery will last at a given rate of discharge is not as simple as "amp-hours" - battery capacity decreases as the rate of discharge increases. For this reason, battery manufacturers prefer to rate their batteries at very low rates of discharge, as they last longer and get higher ratings that way. That is fine if you're building a low-power application, but if your contraption really "sucks juice", you won't be getting the amp-hours you paid for.


Figure 8: Battery

**LCD Display**

A liquid crystal display is special thin flat panels that can let light go through it or can block the light. (Unlike an LED it does not produce its own light). The panel is made up of several blocks, and each block can be in any shape. Each block is filled with liquid crystals that can be made clear or solid, by changing the electric current to that block. Liquid crystal displays are often abbreviated LCDs. Liquid crystal displays are often used in battery powered devices, such as digital watches, because they use very little electricity. They are also used for flat screen TV’s. They work well by themselves when there is other light around (like a lit room, or outside in daylight). The LCD uses technology called electro-optical modulation. This means it uses electricity to change how much light passes through it.

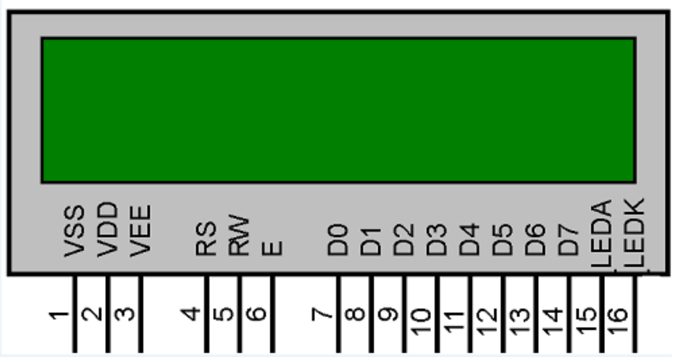


Figure 9: LCD Display

## IV. SOFTWARE DESCRIPTION

### THINGSPEAK

Thing Speak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Thing Speak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates.

Thing Speak was originally launched by ioBridge in 2010 as a service in support of IoT applications. Thing Speak has integrated support from the numerical computing software MATLAB from Math Works, allowing ThingSpeak users to analyze and visualize uploaded data using Mat lab without requiring the purchase of a Mat lab license from Math works.

ThingSpeak has a close relationship with Math works, Inc. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks' Mat lab documentation site and even enabling registered Mathworks user accounts as valid login credentials on the ThingSpeak website. The terms of service and privacy policy of ThingSpeak.com are between the agreeing user and Mathworks.

### 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.Embedded C use 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, unions,etc.The C programming language is perhaps the most popular programming language for programming embedded systems.

### NETWORK C++

C++ is a language specification created by Microsoft and intended to supersede Managed Extensions for C++. It is a complete revision that aims to simplify the older Managed C++ syntax, which is now deprecated. C++/CLI was standardized by Ecma as ECMA-372. It is currentlyavailable in Visual Studio 2005, 2008, 2010, 2012, 2013, 2015 and 2017, including the Express editions**.**

### MySQL

MySQL is an open-source relational database management system (RDBMS). Its name is a combination of “My”, the name of co-founders Michael Widenius's daughter, and "SQL", the abbreviation for Structured Query Language. The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. MySQL was owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation. For proprietary use, several paid editions are available, and offer additional functionality.

### PHP

PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. It is originally created by Rasmus Lerdorf in 1994; the PHP reference implementation is now produced by The PHP Group. PHP originally stood for Personal Home Page, but it now stands for the recursive acronym PHP: Hypertext Preprocessor.

PHP code may be embedded into HTML code, or it can be used in combination with various web template systems, web content management systems, and web frameworks. PHP code is usually processed by a PHP interpreter implemented as a module in the web server or as a Common Gateway Interface (CGI) executable. The web server combines the results of the interpreted and executed PHP code, which may be any type of data, including images, with the generated web page. PHP code may also be executed with a command-line interface (CLI) and can be used to implement standalone graphical applications.

## V. RESULTS AND DISCUSSIONS

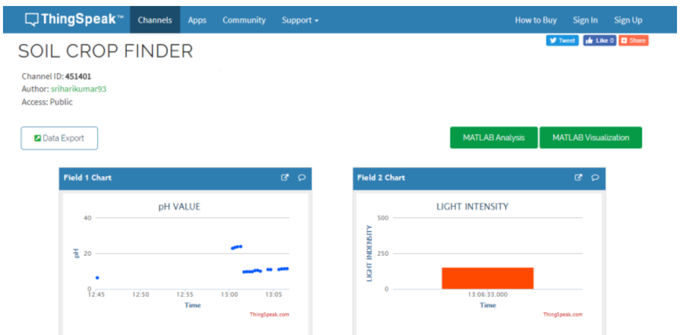


Figure 10:Graph Output


Figure 11:Simulation output showing temperature and humidity

## VI. CONCLUSION

The remote monitoring of the soil pH rate, humidity and its temperature rate has been done with the very minimal cost. The values can be viewed by the farmer's anywhere in the world at any time. Hence this system gives more accurate pH rate, humidity rate and temperature rate of the soil which play vital role in the agriculture. The temperature sensor, Humidity sensor and soil moisture sensor can be interfaced to the microcontroller to access data through Thing speak cloud platform. Graphs are plotted for better analysis. The crop to be planted is suggested by comparing the obtained values of soil parameters with the actual values.

A reliable and continuous vital sign monitoring system targeted towards each farmer's land has been successfully built. The resulting system was also low in power and cost, non - invasive and provisional real time monitoring on the agriculture. It is also easy to use and provide accurate measurements.

Soil's most important parameter for cultivation is its mineral content. Since there is no specific sensor for measuring the mineral content of the soil, we are considering only the parameters such as pH, humidity and soil temperature. The future scope of our project is developing a system which measures the mineral content of the soil along with other parameters for suggesting the crop to be planted.

## VII. ACKNOWLEDGMENT

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