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IoT Application in Irrigation

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Abstract-India is a rich and diverse country where majority of population depends on agriculture for their livelihood. As we all know, Internet of Things (IoT) is the most recent technology coming up these days and this work is an application of IoT in Agriculture/Irrigation sector. The project proposes a system where an agriculture/plant is automatically irrigated based on a defined soil moisture level. Soil moisture sensor is used in the prototype setup which measures the moisture level in the soil and enable the system to avoid over/under irrigation. Internet of Things is used in this system to update the farmer about the status of pump and even receive an alert if the soil moisture is less. These information is available on a webpage to the farmer and graphs will be generated based on sensor readings for various analysis.

Index Terms- IoT, Smart Irrigation

1. INTRODUCTION

Imagine for a moment, every object in our vicinity, the chair we are sitting on, our belongings, our clothes, even our skin are all wirelessly connected to a network of communication and interact using Embedded Technology. Imagine all these things are continuously conveying data about them to the internet, with people can analyse the data and perform an action based on that. This is the Internet of Things. Using the Internet of Things, we are giving the world a digital nervous system similar to our own Brain. It also enables data collection on par with our sensory organs using cameras and microphones connected to the internet. The Internet of Things can offer a range of capabilities for measuring weather changes to sensing a person's vital stats and making this data available anywhere in the world. Currently the hype over IoT is so huge and also we seem to get a new product with IoT enabled each day. The key problems of precision agriculture is to understand how Information Technology can be used manage and monitor crop growth dynamically so that the productivity levels and resource utilization are improved [1-2].

Let's have a look at a few scenarios which would better explain the science behind the Internet of Things:

• Connect with Things

IoT will allow you to connect with things. For example we could just point a smart phone at anything to learn more about it such as a packet of food at a supermarket and find out its ingredients, dietary information and allergy advice. We can also point a camera at a person to find out his or her interest or any information they have agreed to share.

• Monitor Things

We could use the internet of things to constantly monitor or observe things. For example if one has a heart problem, he/she could wear a cardiac monitor which is easily available nowadays. The next generation of this will be linked to the internet. E-health could potentially provide access to motoring system to everyone.

• Transportation

IoT in transportation can help us track vehicles and people, connect infrastructure and make transport work better. The upcoming revolution of driverless cars can occur only with the use of IoT. The cars will relay information to a cloud server which will provide data to other cars that are close by in real time.

• Smart Homes

Smart home stands out currently as a biggest application of Internet of Things on all measured channels. the Amazon echo has inbuilt microphone that can hear us across the room even among other noises. We can use it to get answers, hear news, play music, listen to audiobooks and integrate to other Smart home devices. The Nest thermostat is a highly efficient electric appliance which can help save up a lot on cooling and heating systems. philips Hue bulbs have a luminosity setting for every move that we might have. All the above products are possible only with the internet of things.

Connect with Things

• Health and Security

IoT enables the transmission of our sleep quality data to our physician even before we are fully awake. Later in the day the pill bottle alerts us and our physician office if we haven't taken a blood pressure medication. The refrigerator can autonomously intimate the grocery delivery service that we are running low on life essentials of milk and vegetables. Currently there are consumer based fitness tracking devices like Fitbit and apple Smartwatch which are designed with loads

Monitor Things

of miniaturized sensors. Information collected from these devices will have great benefit for analytical purposes helping us to better understand disease and treatment as well as manage the health of populations.

• Smart Farming

There are Enterprises catering to solutions for smart farming which could help in better visibility of soil and crop health, machinery in use, livestock and produce management. A result of this would be greatly increase food production with better efficiency which is an immediate requirement with the growing human population.

2. METHODOLOGY

Irrigation is the activity of providing water to the crops for its sustainability. In the conventional irrigation system, the farmer manually comes to the field and water his/her crops. Next came the automated irrigation system where watering will be done automatically based on time most of the time. This results in wastage of water. For example, since the time for watering may be pre-programmed, the watering happens even during rainy time. Smart Irrigation is a combination of Automated irrigation system and a sensor network. To create a setup which can monitor soil moisture and accordingly irrigate the farm is possible using Arduino boards with low price moisture sensors[3]. Soil moisture devices/sensors can be placed in the soil to measure humidity in the soil [5].

2.1. *Need of Smart Irrigation*

Smart irrigation is simple and install and configure. It saves energy and resources. Farmers will be able to provide right amount of water for their crops' irrigation avoiding over water and under watering[4]. Motors can be automated easily by using controllers and no need of manual intervention required. Also it saves a lot of man hours.

2.2. *Smart Irrigation – Block Diagram*

The system is a combination of hardware and software components. The hardware part consists of embedded system and software is the webpage designed using PHP. The webpage is hosted online and consists of a database in which readings from sensors are inserted using the hardware.

2.2.1. *Moisture sensor section*

For analysis, soil moisture sensor is placed in different soil conditions. Sensor reads moisture content around it. A current passes across electrodes of the sensor through soil and the soil moisture is determined by the resistance to the current in the soil. Resistance will be low if the soil has more water and vice versa.

2.2.3. *IoT section*

Smart Farming

This section is a combination of a webpage which displays the current status of the motor and also we will get a graphical display of various analytics.

2.2.2. *Control section*

Arduino board receives the information from the sensor which controls the switching ON/OFF of the motor. A tube is attached to the motor for irrigation purpose.

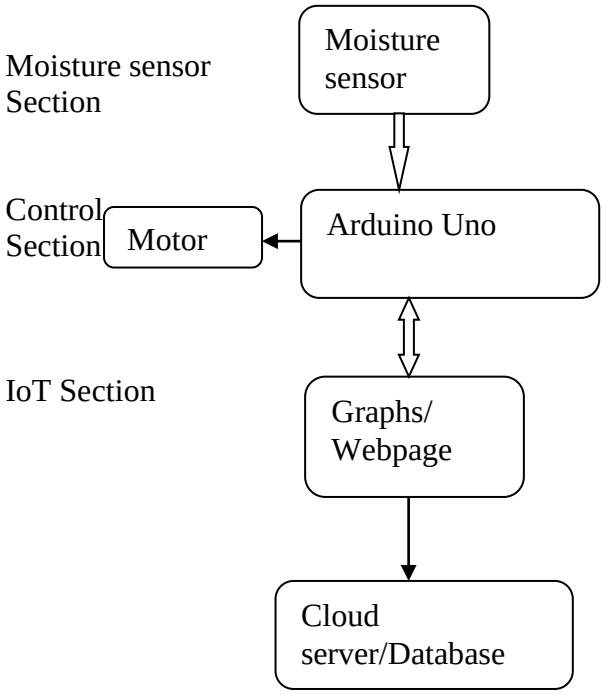

Fig. 1. Smart Irrigation System Using IoT – Block Diagram

3. HARDWARE AND SOFTWARE

This project uses software as well as hardware for its implementation

3.1. *Hardware Used*

- Arduino Uno
- ESP 8266
- Soil sensor
- Water pump
- Motor Driver

- Pin Connectors
- Battery connector
- 9v battery

Arduino which is an open source computer hardware and software company, project, and user community, designs and manufactures microcontrollers and kits for digital and interactive devices which can sense and control objects in the physical and digital world. Arduino is licensed under GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL) which permits the board and software distribution by anyone. UNO is the most commonly used board of the Arduino family. "Uno" is one in Italian. In a series of USB Arduino boards, Uno is the first.

The ESP8266 is a Wi-Fi microchip with full TCP/IP stack and microcontroller capability. It is produced by Shanghai-based Chinese manufacturer Espressif Systems.

Humidity of the soil is usually detected by the soil moisture sensor or the hygrometer. This makes it perfect for building automatic watering systems or monitoring soil moisture. The sensor consists of an electronic board and the probe with two pads which detects water content. The built-in potentiometer does sensitivity adjustment of the digital output (D0).Based on the water content in the soil, the output voltage of the sensor also changes. If the soil is wet, the output voltage decreases and if the soil is dry, the output voltage increases.

3.2. *Software Used*

The Arduino IDE Software runs on Windows, Macintosh OSX and Linux Operating Systems. But most microcontroller system software requirements are limited to Windows only. The Arduino IDE is provided as an open source tool for the beginners and students to write and upload the program onto the microcontroller. Programming of the Uno board is denoted by "Sketches". Each sketch contains variable declaration, initialization and control code. The setup function contains the Initialization variables and Loof function contains the Control code. The program/sketch is saved in .ino format and the various sketch operations like opening, verifying, saving etc. can be done from the tool menu. We should select the suitable board and serial port number from the tools menu. Upload button is used to upload the code to microcontroller.

4. SETUP

4.1. *Interfacing ESP8266 with Arduino*

ESP8266 wifi module is low cost standalone wireless transceiver that can be used for end-point IoT developments. ESP8266 wifi module enables internet connectivity to embedded applications.

Microcontroller uses AT commands to communicate with the ESP 8266.

Table 1. ESP8266 and Arduino interfacing.

ESP8266	Arduino UNO
VCC	3.3 V
CH_PD	3.3V
GND	GND
RX	Pin 4
TX	Pin 3

4.2. *Interfacing Soil Moisture Sensor with Arduino*

Table 2. Soil moisture sensor and Arduino interfacing.

Soil Moisture Sensor	Arduino UNO
A0	A0
GND	GND
VCC	5 V

4.3. *Reading data from Soil moisture sensor*

Below code is uploaded to the Arduino Uno for getting readings from the soil moisture sensor.

```
int srdata;
int prdata;
void setup() {
  // put us setup code here, to run once:
Serial.begin(9600);
pinMode(A0,INPUT);
}
void loop() {
  // put us main code here, to run repeatedly:
srdata=analogRead(A0);
prdata=map(srdata,0,1023,100,0);
Serial.print("Sensor Data:");
Serial.println(prdata);
delay(2000);
}
```

In the serial monitor of the Arduino software, we can see the sensor values change depending on the change in moisture level of the soil.

4.4. *Interfacing Motor Driver and Pump to Arduino*

Microcontroller cannot provide enough power (current or voltage) required for Motors. Hence a motor driver is used for driving the motor.

4.4.1. *Interfacing Motor Driver and Pump*

Table 3. Motor driver and pump interfacing

Pump	Motor Driver
+ ve	MA 1
-ve	MA 2

4.4.2. *Interfacing Motor Drive and Arduino*

Table 4. Motor driver and Arduino interfacing

Motor Driver	Arduino Uno
V -	GND
Enable A	5 v
Input A 1	Pin 10
Input A 2	Pin 8

Also, Interface Battery connector and Motor Driver by connecting VCC and GND pins

5. SCHEMATICS

5.1. *Project Schematics*

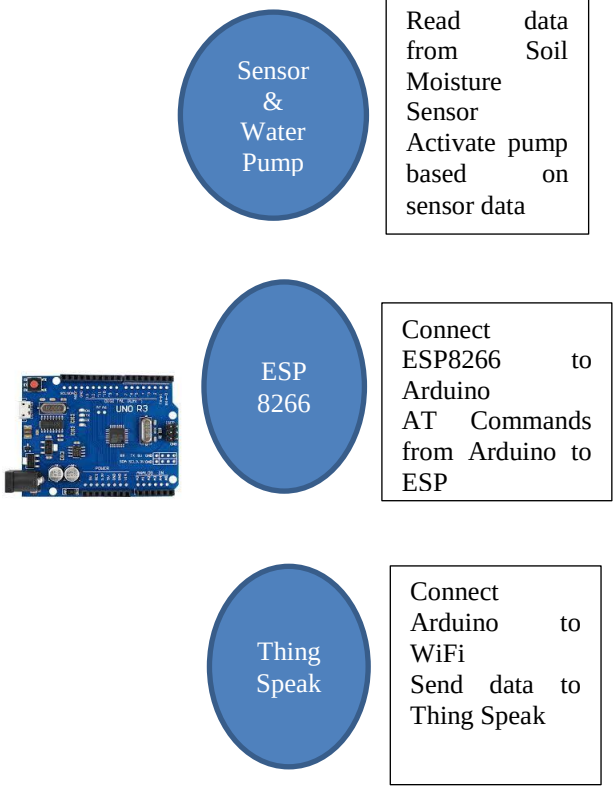

Fig 2. Project Schematics

Arduino Uno is the core embedded system of this project. This Arduino Uno acts as the central driving system of the project and has to be interfaced with three different components of the system namely the Soil moisture sensor and water pump, ESP 8266 and ThingSpeak API.

The Arduino needs to capture data from the Soil moisture sensor and also run the water pump based on the data acquired from the sensor. We also write code to connect ESP8266 to the Arduino and send appropriate AT commands from the Arduino to the ESP8266. Finally we will write code to connect the Arduino to wifi and send soil moisture sensor and water pump data to ThingSpeak. The combination of all these codes will lead to the design of Arduino sketch required to run the Smart Irrigation System.

5.2. *Connection Schematics*

Table 5. Project connection schematics

Component 1	Pin	Pin Description		Pin	Pin Description	Component 2
Arduino Uno	A0	Analog Read	→	A0	Analog Data	YL – 38 Soil Moisture Sensor Module
	5V	Vcc		Vcc	-	
	GND	Ground		GND	Ground	
Arduino Uno	8	Digital I/O	→	A2	Input 2	L293D Motor Driver connected to Water Pump
	GND	Ground		A1	Input 1	
	5V	Vcc		ENA	Enable	
	GND	Ground		GND	Ground	
Arduino Uno	3 (Rx)	Receiver	→	Tx	Transmitter	ESP8266
	4 (Tx)	Transmitter		Rx	Receiver	
	3V3	3.3 V		Vcc	-	
	3V3	3.3V		CH_PD	Chip Enable	
	GND	Ground		GND	Ground	

.

Code to connect ESP8266 to connect with the Arduino, get data from sensor and based on the threshold value of moisture set, make the pump ON or OFF is written [6]. The readings are reflected in the Thingspeak API and we can monitor the same in our mobile.

We also use Viruino, an Android mobile app which links with the Thingspeak API. The app is configured in such a way that we get Alarm in our mobile when the moisture content in the soil is less.

6. GRAPHICAL REPRESENTATIONS

ThingSpeak is an IoT API which is open-source. It is used to retrieve data from things over the internet using HTTP.
The below figure shows the Thingspeak graph for the Soil sensor and water pump status. We can see the sensor values and since its value is higher than the

threshold value set (In our project, it is set as 20), the pump status value is 0.

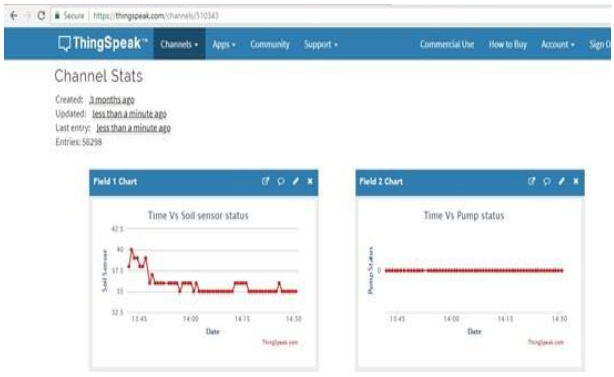

Fig 3. Thingspeak graph under normal condition

In the below figure we can see that as soon as the soil moisture sensor value drops below the threshold value, the pump starts working and shows the status value as 100.

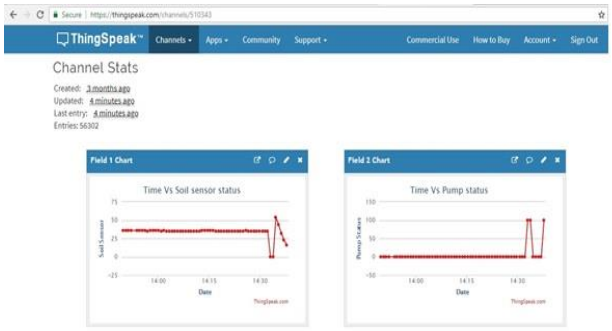

Fig 4. Thingspeak graph when moisture level drops

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