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AN ADVANCED SYSTEM FOR ENVIRONMENTAL MONITORING USING IOT ARCHIECTURE

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ABSTRACT

Environmental monitoring is a highly valuable job in the modern years. Due to the lack of environmental awareness, the man is becoming a major cause for many environmental problems such as pollution, global warming. By developing a system that keeps an eye on the climatic changes, awareness can be created amongst the public and the Earth can be protected from further damage. This paper presents a system that uses the Internet of Things (IoT) technology which is capable of collecting data from the environment and save this data in cloud. The data can be used for further analysis and can be used to alarm the public during abnormal weather conditions. Sensors are used to collect data from environment. A data stream is created to post the data collected from the environment.

KEYWORDS: Cloud posting, Data Stream, Environmental monitoring, Internet of Things.

INTRODUCTION

The global warming is a buzz word in the world around us as it is affecting the normal living of a common man. Excess rains and draughts are the results of this effect. The CO_2 level at Antarctica has crossed 400 ppm (particles per million) in the atmosphere which that happened only before 2 lakh years ago [1]. The main reasons for this are deforestation, use of unconventional fuel sources such as petrol, diesel, kerosene, charcoal etc. Gases emitted by the combustion of these fuels causes the temperature to trap on the Earth's surface which otherwise escapes into the atmosphere. This causes increase in the temperature on the Earth surface.

The global warming has direct and indirect effect on the environmental and social aspects of the human beings. Glacier retreat, changes in the timing of seasonal events and agriculture productivity are examples of environmental changes. The human-driven climatic changes can be resolved by reducing gas emissions and adapting new climatic policies to safeguard the environment.

Near-term climate change policies could significantly affect long-term climate change impacts. Stringent mitigation policies might be able to limit global warming (in 2100) to around 2 °C or below, relative to pre-industrial levels.[8] Without mitigation, increased energy demand and extensive use of fossil fuels might lead to global warming of around 4 °C. Higher magnitudes of global warming would be more difficult to adapt to, and would increase the risk of negative impacts.

The social problems include reduction in the agricultural productivity, draughts, health problems, etc. Global warming can be controlled by reducing the amount of carbon that pollutes the environment. Rules for allowed emission must be strictly followed so that vehicles which emit pollutions above the permitted levels can be seized. Use of CNG gas for vehicles is another option. Usage of thermal energy for energy generation is another cause for global warming. By replacing this with efficient energy technologies and make industries follow these regulations can be handy. The tropical deforestation and its associated global warming emissions are to be strictly prohibited.

EXISTING SYSTEMS

The weather monitoring system can be used to measure weather parameters such as Carbon di oxide (CO2), temperature, humidity, pressure etc. and helps in preventing natural disasters and hazards in nature. The systems in general are automated to avoid human intervention. The weather information gathered can be used to evaluate the climatic changes over a specific duration and to make weather forecast reports. The data can be used in many different ways such as farmer information system, weather forecasting, public display etc.

Figure 1:

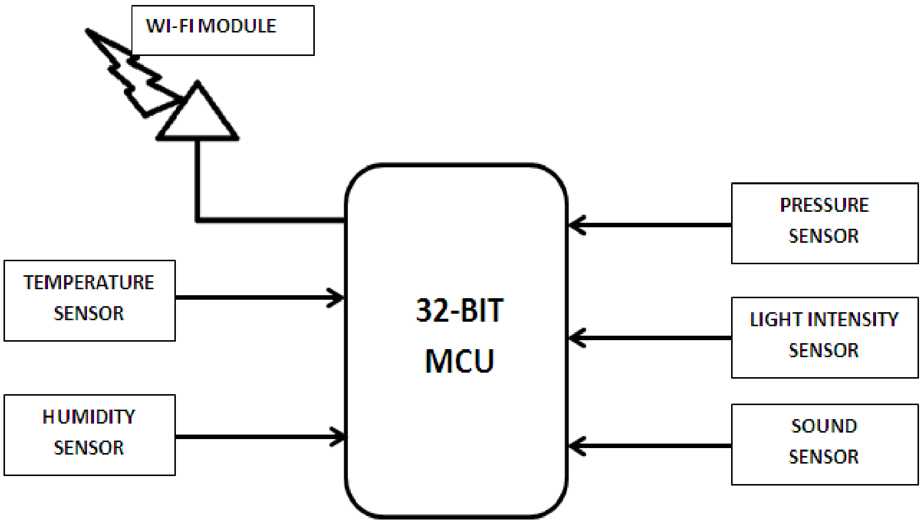
Industrial Emission, one of the primary sources for global warming

Most of the existing systems use some microcontroller based processing of data and uses a sensor network to collect physical parameters. To store the collected data, we need to maintain a database. Normal data bases cannot handle such huge data. So we can use big data platform augmented with a cloud server. Temperature measurements are taken free from direct solar radiation or insulation and humidity measurements are directly taken from the soil. The weather parameters measurements are taken through the weather sensors.

SYSTEM DESIGN

Figure 2 shows the block diagram of the system design. As indicated, we use different sensors to gather information about various parameters in the atmosphere. The system uses Lolin NodeMCU [3] microcontroller. Figure 3 shows the Node MCU.

Figure 2:



Block diagram of the proposed system

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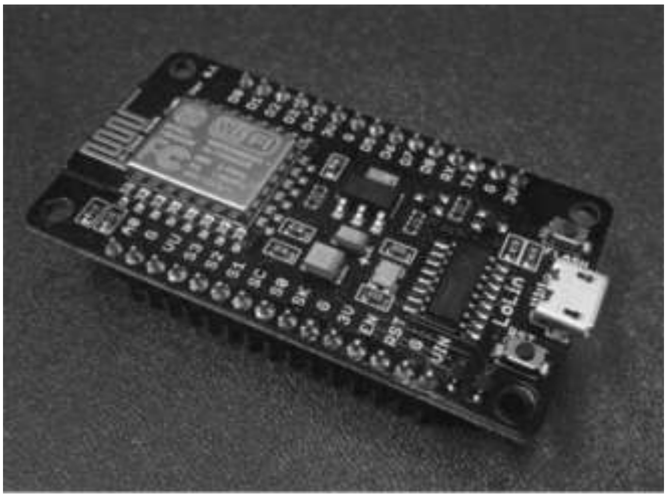
This microcontroller has built-in wi-fi module that reduces complexity of interfacing the wifi module with a microcontroller. The Node MCU is Arduino [4] compatible and hence a code written for Arduino can be directly dumped into the NodeMCU and run it. There are some minor changes in the pin assignments and the corresponding pin mappings are shown in Figure 4.

As you can see from Figure 4, we can use D1 in NodeMCU instead of pin 5 in Arduino, D2 for pin 4 and so on. In this way, by making small changes to the Arduino code, we can use it for NodeMCU. The ESP8266 wifi module [5] is built in with NodeMCU. It contains a 32-bit Tensilicon 80MHz microprocessor and 4 MB of flash memory. The unit has a built-in support with dedicated pins for UART, SPI and I2C protocols.

Figure 3:



Lolin NodeMCU

It has 10 GPIO pins among which nine are digital input output pins and one is analog input with built-in ADC. The NodeMCU is low cost and its smaller size is added advantage.

The NodeMCU requires a current of 250 mA for its normal operation. At its full load capacity it needs a maximum of 600 mA current for its proper functioning. The controller uses a open source firmware and many API (Application Programming Interface) libraries are available [6].

Figure 4:

```
static const uint8_t D0   = 16;
static const uint8_t D1   = 5;
static const uint8_t D2   = 4;
static const uint8_t D3   = 0;
static const uint8_t D4   = 2;
static const uint8_t D5   = 14;
static const uint8_t D6   = 12;
static const uint8_t D7   = 13;
static const uint8_t D8   = 15;
static const uint8_t D9   = 3;
static const uint8_t D10  = 1;
```

Pin Mapping between Arduino and NodeMCU

SHT25 Temperature Humidity Sensor

Sensirion's SHT25 is a high-precision digital humidity and temperature sensor for applications with stringent accuracy requirements. The reflow-solderable SHT25 precisely measures relative humidity (RH) over a range of 0–100 per cent RH and temperature over a range of -40°C to +125°C. The sensor achieves a typical accuracy of

1.8 per cent RH (at 25°C) for relative humidity and ±0.2°C for temperature. For both quantities, the typical tolerance is small even at the limits of the measuring range. The maximum tolerance is 2% relative humidity or ±0.3C over a wide range. The major features of SHT include I2C interface, good stability, low power consumption, quality management system and individual sensor tracking data. I2C address: 0x40.

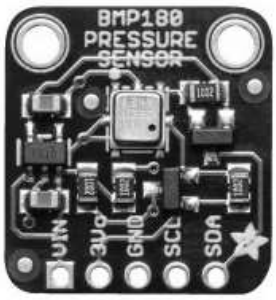
Figure 5:

SHT 25 Temperature and Humidity Sensor

BMP180 Pressure Sensor

This is a Grove module for the Bosch BMP180 high-precision, low-power digital barometer. The BMP180 offers a pressure measuring range of 300 to 1100 hPa with accuracy down to 0.02 hPa in advanced resolution mode. It’s based on piezo-resistive technology for high accuracy, ruggedness and long term stability. The chip only accepts 1.8V to 3.6V input voltage. However, with outer circuit added, this module becomes compatible with 3.3V and 5V. Therefore, it can be used on Arduino without modification. It is designed to be connected directly to a micro-controller via the I2C bus. The key features of this sensor are Digital two wire (I2C) interface, Wide barometric pressure range, Flexible supply voltage range, Ultra-low power consumption, Low noise measurement, Factory-calibrated, -40 to +85°C operational range, ±2°C temperature accuracy I2C address: 0x77.

Figure 6:



BMP180 Pressure and Altitude Sensor

KY037 Sound Sensor

Figure 7:

KY037 Sound Sensor

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Adding a Arduino microphone to the project gives you the ability to detect sound. Whether it's clapping, talking, shouting, or even a pin dropping the KY037 electret microphone breakout board will detect it. The KY037 Arduino compatible microphone features a built in electret microphone, high sensitivity amplifier and adjustable potometer for sensitivity tuning. This Arduino compatible sensor also features two outputs: Analog output (AO) which outputs real time voltage signal changes and a Digital output (DO) which outputs a high or low signal when the sound intensity reaches a threshold limit. Paired with the starter Arduino Microphone Code provided below you will be well on your way to developing cool new sound detection projects that will have everyone shouting about! The sensor come fully assembled, features a 3 mm mounting hole and operates at 5V with a built in indicator LED.

MG-811 - CO2 Sensor

MG-811 onboard as the sensor component. There is an onboard signal conditioning circuit for amplifying output signal and an onboard heating circuit for heating the sensor. The MG-811 is highly sensitive to CO2 and less sensitive to alcohol and CO. It could be used in air quality control, ferment process, in-door air monitoring application. The output voltage of the module falls as the concentration of the CO_2 increases. The key features are analog and digital output, onboard signal conditioning circuit and onboard heating circuit.

Figure 8:

MG-811 CO_2 Sensor

BH1750 Light Intensity Sensor

This is a BH1750 light intensity sensor breakout board with a 16 bit AD converter built-in which can directly output a digital signal. There is no need for complicated calculations. This is a more accurate and easier to use version of the simple photo resistor which only outputs a voltage that needs to be calculated in order to obtain meaningful data. With the BH1750 Light Sensor intensity can be directly measured by the luxmeter, without needing to make calculations. The data which is output by this sensor is directly output in Lux (Lx). When objects which are lighted in homogeneous get the 1 lx luminous flux in one square meter ,their light intensity is 1lx.

Figure 9:

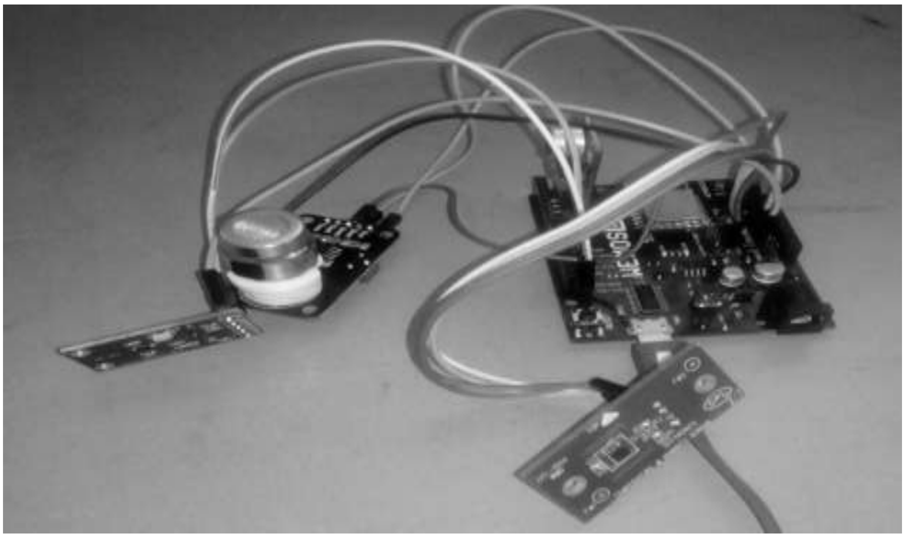
Light Intensity Sensor

Sometimes to take good advantage of the illuminant, you can add a reflector to the illuminant. So that there will be more luminous flux in some directions and it can increase the illumination of the target surface.

RESULTS

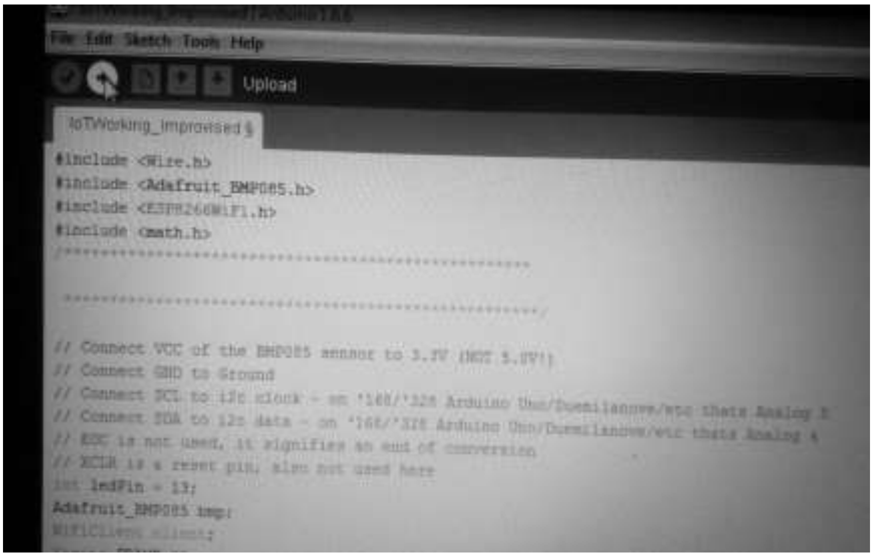
A data stream is created at data.sparkfun.com to post data and store it in a server. The data.sparkfun.com is a free cloud service provided by sparkfun.com, a popular electronics component vendor. We have created a stream with alias mtech_wms, which is available in the public domain. A screenshot of some values posted is shown in Figure 12.

Figure 10:



Experimental Setup

Figure 12:



Program Compiling in Arduino IDE

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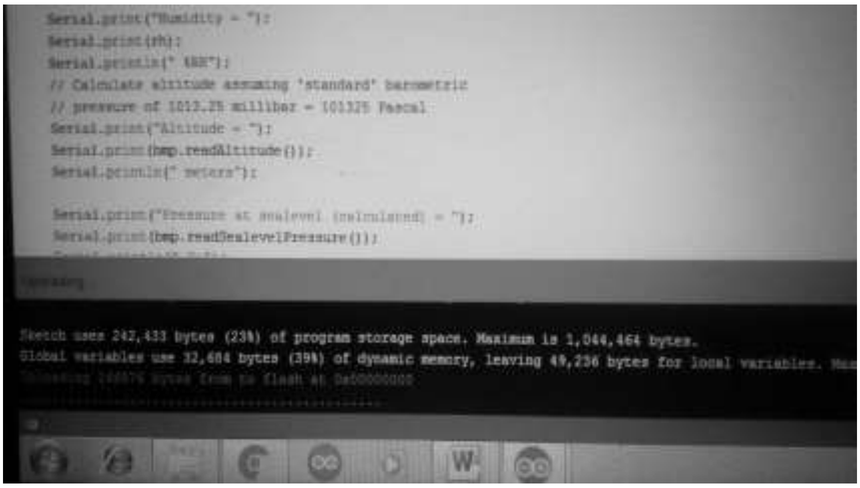
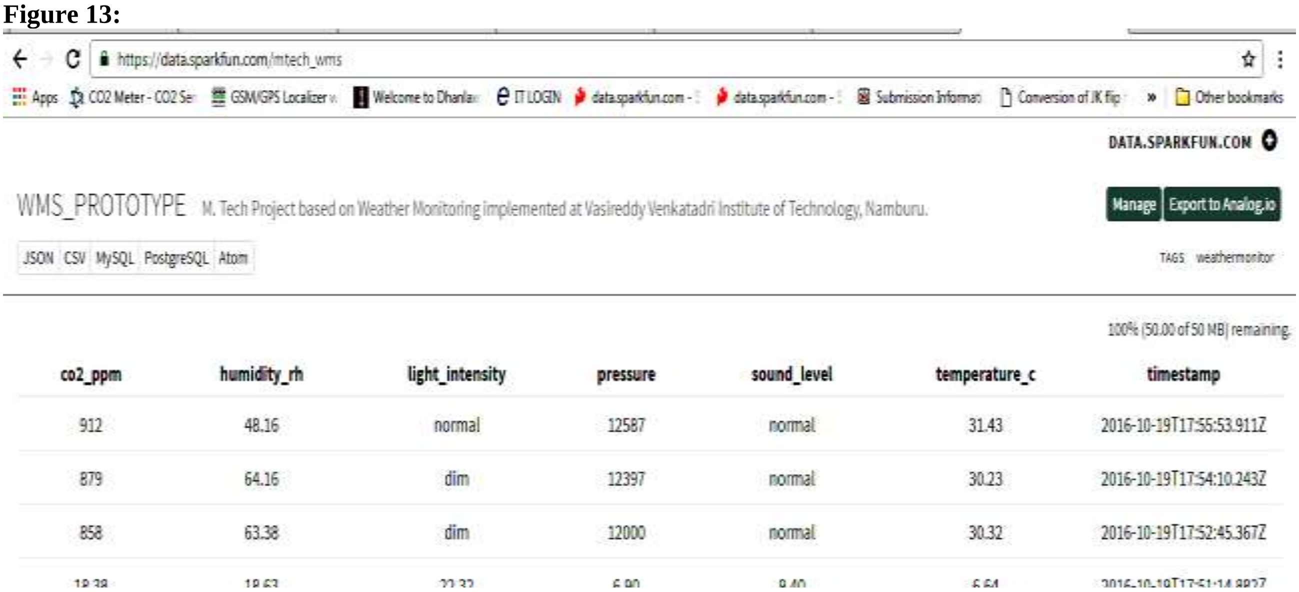
Figure 12:



Uploading Process

Figure 13:



Data stored in the Cloud at www.data.sparkfun.com/mtech_wms

CONCLUSION

We have developed a prototype of Weather Monitoring System using the advanced IoT architecture. The system finds its applications in the weather forecasting, agriculture information system, and other meteorological analysis. With advances in the fields of microcontrollers and sensors, accuracy of the data is very high and results show that the system is highly adaptable. Further, adding few sensors like pH, moisture and water level, the system can be made into a wonderful weapon for researchers in the area of agriculture. The system consumes less power, and is cost-effective.

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