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Industrial Process Automation and Monitoring Using IOT

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ABSTRACT

The present industrial revolution is the industry 4.0. The main aim of the revolution is the replacement of old communication which uses wire links as medium with new communication that is wireless communication. The main reason to move to such a type is improve scalability, improve mobility and reduce the time and cost of production. To achieve this, the type of application should be taken into consideration and also the communication protocol must be robust and support low loss transfer. The present industrial revolution uses different technologies, one such is Internet of Things (IOT). IoT is a rapidly increasing technology, it is a network of different physical objects with embedded sensors, software, and network connectivity which enables the objects to collect and exchange data. In this paper, we are proposing an automation system which can take intelligent decisions for an industrial application and can also automatically monitor and generate alerts using concept of IoT. The contribution of this paper is the demonstration of the use of IoT of the system in the latest industrial revolution. IoT helps to improve the accessibility of the application from anywhere in the world. IoT connects anything to the internet using specified protocols, which allows devices to communicate intelligently to smart monitoring and also improving power efficiency.

Keywords— Automation, Industry 4.0, IoT (Internet of Things), NodeMCU.

1. INTRODUCTION

Industrial automation can be defined as the use of different control systems that handles different machineries and processes in an industry to reduce human efforts. The present-day purpose of automation shifted to increasing flexibility and quality in a process from increasing productivity, security to employees and cost reduction associated with human operators. This kind of automation eliminates cost regarding healthcare, paid leave and holidays associated with a human. Also, the maintenance cost related with machinery in industry is less because only

maintenance engineers are made to repair it. All this is usually associated with high initial costs but it leads to large cost savings later for the industry. [3]

Internet of Things was introduced in 1999 and since then, it has become popular along with the development of embedded devices, latest communication protocols, cloud computing and data analysis. IoT allows different sensor after sensing, to share information regularly and communicate with all the devices which are interconnected over the internet. This data is then analyzed to make and take intelligent decisions to manage the production intelligently. IoT allows sharing of information with different devices connected through the internet, from which we achieve smart monitoring and administration.[2]

The Industrial Internet is a coming together of several key technologies in order to produce a system greater than the sum of its parts. The latest advances in sensor technologies, for example the sensor can produce data that is not just precise, but predictive. Similarly, machine sensors through their controllers can be self-aware, self-predict and self-compare. For example, they can compare their present configuration and environment settings with preconfigured optimal data and thresholds. This provides for self-diagnostics. Sensor technology has reduced dramatically in recent years in cost and size. This made the instrumentation of machines, processes, and even people financial and technically feasible.[6]

2. LITERATURE REVIEW

IoT can be considered as a worldwide network infrastructure consisting of various connected devices that depend on different processing technologies such as sensory, communication, networking and information. The start of IoT technology is the RFID technology, this technology allows microchips to transmit the devices identification information to any reader via wireless communication. RFID enables anyone to identify, track and monitor various objects attached with RFID tags automatically. RFID applications can usually be found at logistics, pharmaceutical productions, and supply chain management. Another technology which helped in the start of IoT is the wireless sensor networks (WSNs), which uses interconnected intelligent sensors for sense and monitoring. Its applications include all kinds of monitoring systems like environment, healthcare, industrial. In order for IoT to provide high quality services to end users, technical standards are needed to define different specifications for information exchange, processing, and communications between things. The future Success highly depends on standardization, which provides various characteristics like interoperability, compatibility, effective operation, and reliability on world scale. Many countries in the world are looking forward to the development of IoT standards because it can bring huge economic benefits in future. [1]

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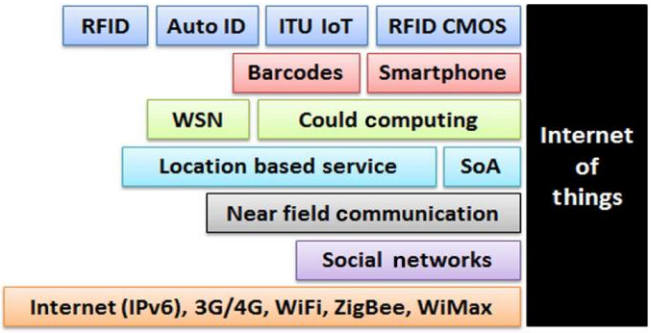


Figure 1.technologies associated with IoT.

Present day system does not offer high performance at cost effective prices. If at all they offer, it is hard to install and difficult to maintain. The demerits of some existing systems are described below.

Automation system using Bluetooth: This type of system is limited by range and number of devices that can be connected. [3]

Automation system using Zigbee: This system is still running on Bluetooth technology, although it overcomes drawback of Bluetooth system, it still lacks range of operability. [3]

Automation system using GSM: when compared to above systems, it consumes standalone power. But it fails to deliver commands when the GSM network fails. [3]

All the systems discussed may have individual advantages but lack of standardization is visible all along.

2.1 Application of IOT

Applications related to IoT are still in early stages, but the use of it is rapidly evolving. Only a few applications are considered for being developed and deployed in different industries such as environmental monitoring, food supply chain, security and surveillance, etc. Some of IoT applications related to industries are: [1]

Healthcare service industries, Food supply chain, For safer mining production, For transportation and logistics, In firefighting, In smart environment monitoring, and in smart agriculture.

3. PROPOSED SYSTEM FOR INDUSTRIAL AUTOMATION

Industrial alerts are based on manual intervention, appropriate notifications for any circumstances in industries are not provided. In my proposed system, nodemcu is used as a controller which also has the capability of connecting to internet as it contains Esp8266 microcontroller via Wi-Fi. System also contains several components such as Ultrasonic ranging module for level measurement, DHT 11 temperature and Humidity sensor, 16/2 LCD module, 4channel relay module, water pump, a fan and a buzzer for local alerts. The system can provide both monitoring and

alert capabilities both locally and via internet worldwide. Information can be monitored using Thingspeak.com which is an open source IoT analytics platform which allows aggregating, visualizing, and analyzing live data in the cloud. It also has the ability to execute MATLAB code which allows performing online analysis and processing of data.

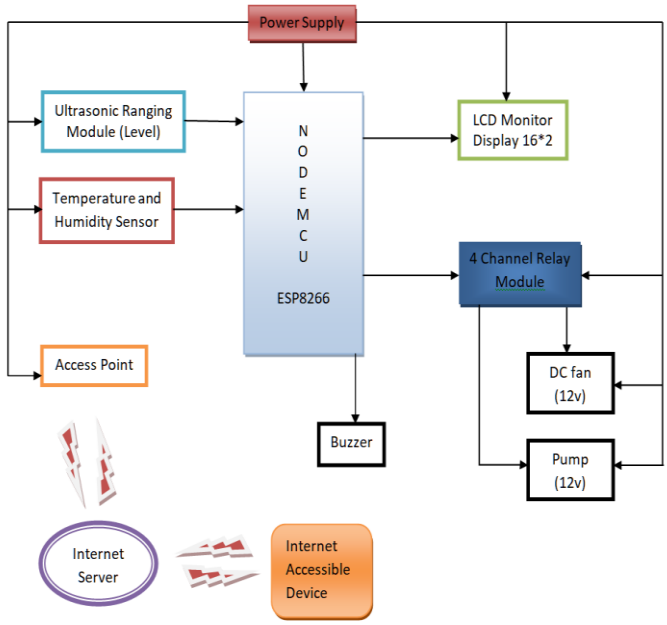


Figure 2. block diagram

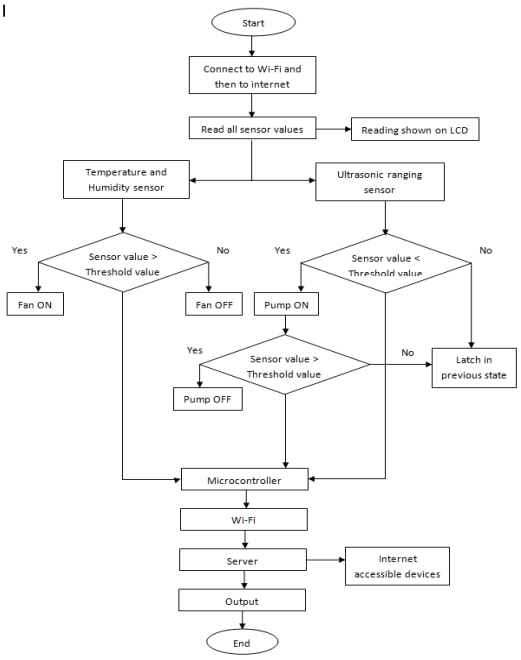


Figure 3. flow chart.

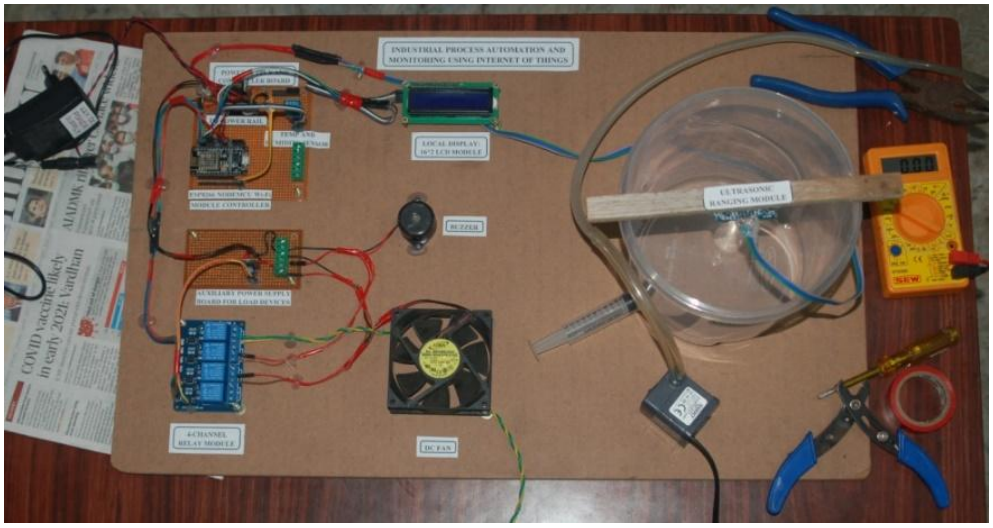
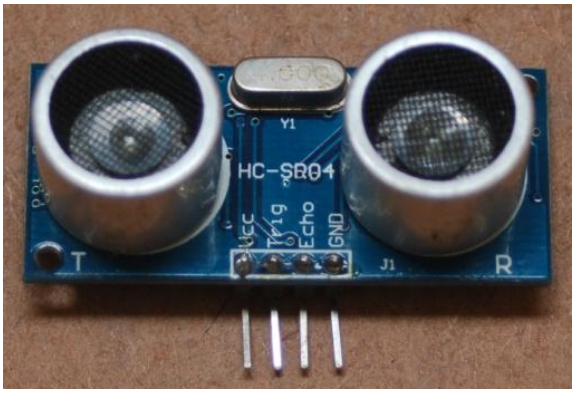


Figure 4. proposed system.

3.1. ULTRASONIC RANGING MOUDLE

HC-SR04 is an inexpensive ultrasonic ranging module that can measure a distance range of 2 cm to 400 cm without any contact. The accuracy can be as low as 5mm and the effective angle is <30°. It needs a 5V dc power supply.

This module consists of anultrasonic transmitter, a receiver and acontrol circuit. The basic principle of working includes 3 steps: (1) Using IO trigger for at least 10us high level signal, (2) The Module will automatically send eight 40 kHz ultrasonic pulses and detects whether there is a reflected signal back. (3) If the signal returns back, according to the time of high output duration from sending ultrasonic to returning. distance = (high level



time*velocity of sound (340M/S) / 2.

Figure 5. hc-sr 04 Ranging Module

3.2. 16*2 LCD MODULE

Operating Voltage of the device ranges from 4.7V to 5.3V. Current consumption is 1mA without backlight. It is called as Alphanumeric LCD display module, because it can display both alphabets and numbers. It consists of two rows and each row can print 16 characters.Each character is built by a 5×8-pixel box that is 40 pixels and for 32 characters it is 1280 pixels. It can work on both 8-bit and 4-bit mode. It can also display any custom generated characters. Available in Green and Blue Backlight.An Interface IC like HD44780is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen.

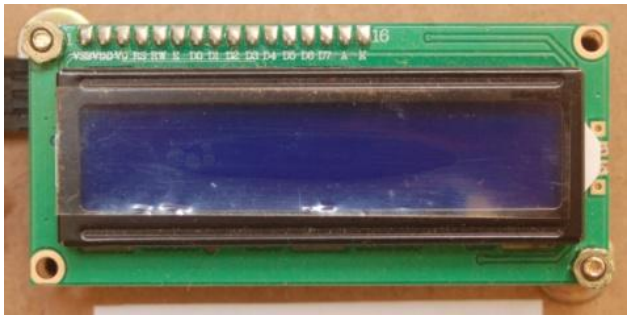


Figure 6. 16*2 lcd module

3.3. NODEMCU

The NodeMCU ESP8266 development board comes with the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.NodeMCU can be powered using Micro USB jack and VIN pin (External Supply Pin). It supports

UART, SPI, and I2C interface.

Figure 7. Nodemcu

3.4. DHT 11

The DHT11 is a commonly used Temperature and humidity sensor with calibrated digital signal output. The sensor consists NTC thermistor to measure temperature, a resistive type humidity component and an 8-bit microcontroller to output the values of temperature and humidity as serial data.This sensor has a measuring range of 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1.

Figure 8. dht11 Module

3.5. RELAY MODULE

This is a LOW Level 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller. This module is optically isolated from high voltage side for safety requirement and also prevent ground loop when interface to microcontroller. The output capacity of the relay is DC 30V/10A, AC 250V/10A.
It has three terminals namely a common,a normally open, one normally closed.

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Figure 9. Relay Module

Figure 10. Dcfan.

Figure 11. Buzzer.

Figure 12. Water Pump.

4. IMPLEMENTATION

The power supply provides 12v Dc supply to the system. When the system turns active, Initially the values of Thing speak server are being cleared so that previous values does not required to be stored after each restart. Then the system is started and simultaneously the Wi-Fi module is powered and connection is established between Wi-Fi module and internet access point through which data can be uploaded and access the sensor value over internet.

According to the code, the different sensors data i.e. temperature, level and Humidity are read and taken by the controller, and according to the set point constraints, the controller implements the program code logic (Arduino IDE software) on the sensor data to make necessary control acting. The control includes

1. Turning the water pump on and off.
2. Turning dc fan on and off.
3. Buzzing alerts through buzzer.

When the level reaches low the pump latches ON till the level reaches the set point, while buzzing alerts both locally and in the web. Similarly, Fan turns ON when the temperature is high and turns off when it reaches low set point, while buzzing alerts both locally and in the web. And at the same time, the controller also uploads the process status (data collected from the sensors) live to the web server through the esp8266 Wi-Fi module then in the server the data is plotted in a graphical manner. And also, is displayed repeatedly on the onsite LCD display. This can be both monitored from anywhere far away from the process or at the site of process at any point in time.

5. RESULTS

The pictures depicted below signifies that the proposed system is able to operate, able to control the process and data is getting updated to the server and monitoring is happening with the help of Thingspeak.com

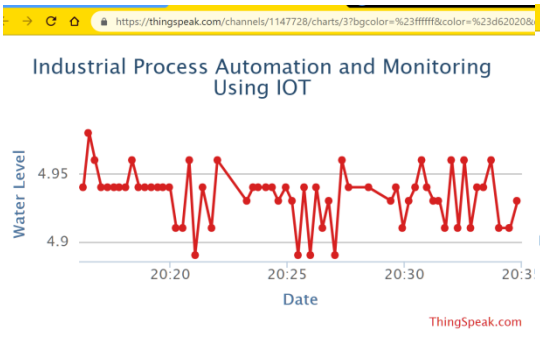

Figure 13. Water Level Monitoring

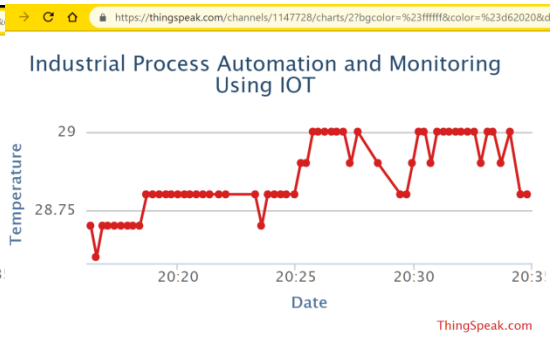

Figure 14. Temperature Monitoring

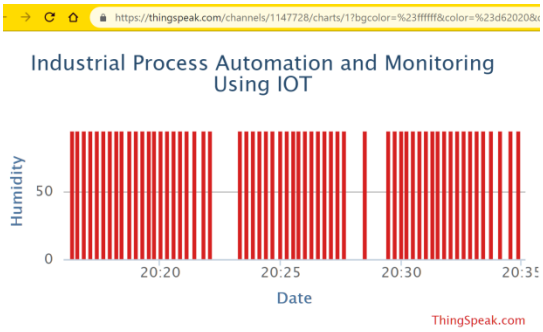

Figure 15. Humidity Monitoring

Figure 16. Pumping Water into Tank.

Figure 17. Temperature Data.

Figure 18. Temp High Warning.

Figure 19. Water Level in Tank

Figure 16. Tank Low Warning

6. CONCLUSIONS AND FUTURE WORKS

In the field of embedded systems, Internet of things is a popular asset for the fourth industrial revolution and is also has become an important topic for research. IoT system is a heterogeneous system as different software and physical devices are interconnected together. Industrial automation with IoT has huge scale of improving in both hardware and software, reduces human intervention and provides monitoring capabilities which can be smart monitored from anywhere in the world

Itis widely accepted that the technologies and applications related to IoT are still in the infant stage. There are still many different challenges for industrial uses such as privacy, security, standardization, technology. Definitely good efforts are needed to address all these different challenges and examine different characteristics of industries to ensure the IoT devices are well fitted in industrial environments. Strong understanding of these characteristics and different requirements such as privacy, security, and cost is required for IoT to be accepted and deployed in industries.[1]

IoT is very complicated network, it includes connection through various communication technologies between different types of networks. At present, there is a lack widely accepted common platform which can cause frequent delays and communication issues when dealing with large amounts of data at the same time.

It takes lot of work to link IoT with existing Information Technology infrastructure, because integrating IoT devices with existing software and web services requires different middleware solutions that can become difficult task for various industries.

For the new IoT technologies to be accepted and widespread, the data privacy protection and information security is very much needed and are difficult to achieve because different existing technologies which are available now are not suitable with strict safety and security requirements of industries.

7. ACKNOWLEGDGEMENTS

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