Water Quality Monitoring and Control using IoT and Industrial Automation

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Abstract

This paper investigates water quality monitoring and control system using Internet of Things and Industrial Automation. Using this system, remote monitoring and controlling is achieved. Power requirement is also reduced greatly as embedded based web servers are used instead of using PC based servers. Input of this system consists of water quality measurement sensors such as temperature, pH and turbidity sensors, interfaced with raspberry pi. This sensed data is passed to cloud/Node red server, where stored data can be monitored remotely. If any of the data is found above some threshold value, then appropriate controlling action is taken on the device, which is connected at the output of PLC, from any remote location. This is achieved by using Node red webpage. Sensed data is stored, analyzed and accordingly controlling action is taken on the device. Device used here for controlling action is DC motor connected to motor pump.

Keywords: Industrial automation, Internet of Things, PLC, Remote controlling, Remote monitoring, Water quality monitoring

I. INTRODUCTION

Current industrial and automation monitoring and control systems makes use of PC based servers. Devices in these monitoring systems are connected to these servers and therefore there is necessity to keep this server ON all the time which increases power requirement and hence increases cost of the system. The solution to this problem is to use embedded based web server instead of using PC based server. This embedded web server implementation can be achieved with the help of Raspberry Pi board. This server allows remote monitoring of industrial environment and also web access to the automation and monitoring system and provides remote controlling of industrial appliances as well.

The user can surf the web page of the system using local web browser and can control the industrial devices and know about their status from remote place. This project develops a low cost electronic system which is designed for monitoring and controlling industrial devices via web browser from remote place. At the same time user can monitor sensor data at industry in real time through different sensors installed at industry.

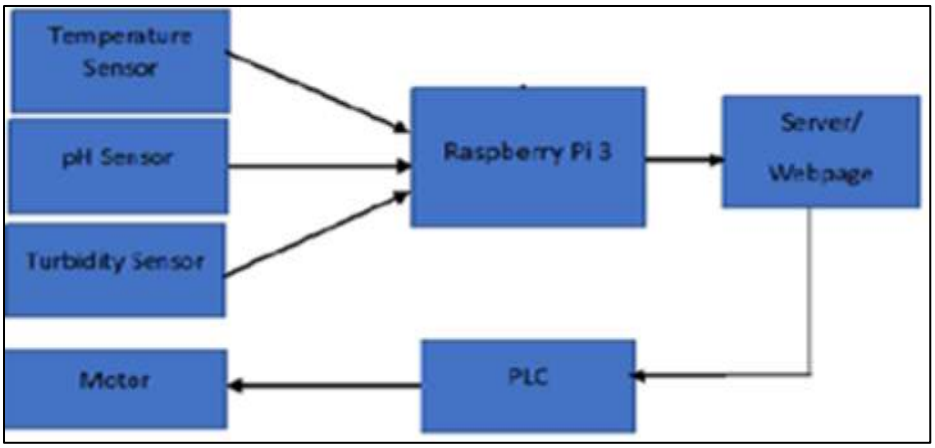
Raspberry Pi (Raspbian OS), and Python are freely available for users to use and also to develop. Security will be critical for many applications and devices. These applications and devices are applied into specific domain of our everyday life like industry, education and in hospitals. Security is very much essential in all kind of application activities. This system is handled by particular user only, and hence the system is more secured. Internet of Things (IoT) is rapidly increasing technology. IoT is the network of physical objects or things embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. In this paper, we are developing a system which will monitor the industrial applications and controlling action using IoT concept. IoT has given us an effective way to make powerful industrial systems and applications by using Raspberry pi.

II. LITERATURE REVIEW

Recent advances in communication technology, including wireless sensor networks have inspired numerous remote sensing and control applications. Here, we focus on the monitoring and control of water quality in natural water bodies such as rivers and lakes. An intelligent system that combines monitoring and actuation capabilities is designed. Major technical challenges such as sensor selection and control over wireless networks are discussed and appropriate algorithms are adopted based on system design requirement [1]. Some of the recent work includes design and development of a water quality monitoring system, with the objective of notifying the user of the real-time water quality parameters. In this design, Zig-Bee receiver and transmitter modules are used for communication between the measuring and notification nodes [2]. The objective of this project is to develop an automatic wireless system to intimate the message to concerned authority when the waste water from industries are mixed with river illegally [3]. This paper presents a low cost and holistic approach to the water quality monitoring problem for drinking water distribution systems as well as for consumer sites [4]. This paper proposes a novel design based on IEEE 802.15.4 (Zig-Bee protocol) and solar energy called Autonomous Water Quality Monitoring Prototype (AWQMP). The prototype is designed to use ECHERP routing protocol and Arduino Mega 2560, an open-source electronic prototyping platform for data acquisition [5].

III. SYSTEM ARCHITECTURE

A. Block Diagram



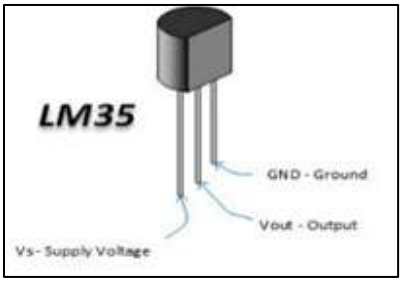
The temperature sensor, pH sensor and Turbidity sensors are interfaced to Raspberry pi 3 with the help of ADC (MCP 3208). Analog data from sensors is first converted to digital data and then it is passed to raspberry pi 3 using SPI communication protocol. Raspberry pi 3 is interfaced to server (NODE RED platform), where all the sensor data is stored and can be monitored remotely. For controlling of PLC output remotely, it can be done using Node red webpage and hence remote controlling of DC motor, which is interfaced to PLC, is achieved.

B. Components and Their Interfacing Details

1) Raspberry Pi Processor

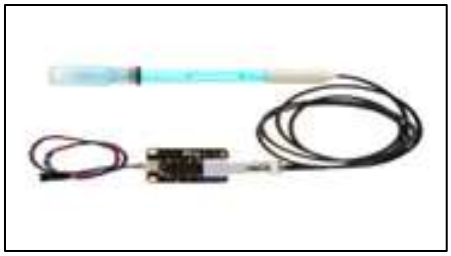
The Raspberry Pi board involves a processor and snap shots chip, Random Access Memory (RAM) and more than a few interfaces and connectors for external devices. Some of these instruments are main others are optional. It operates in the identical method as an ordinary pc, requiring a keyboard for command entry, a show unit. considering that raspberry Pi board operates like pc, it requires mass-storage, but a tough disk pressure of the variety observed in an ordinary pc is not relatively in maintaining with the miniature dimension of Raspberry Pi.

2) Temperature Sensor



The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermistor. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C. It is connected to channel 0 of ADC(MCP3008).

3) pH Sensor

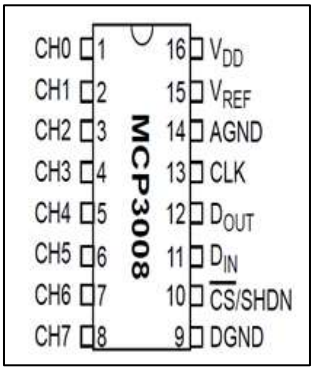


The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply. The normal range of pH is 6 to 8.5. It is connected to channel 1 of ADC(MCP3008).

4) Turbidity Sensor

The sensor operates on the principle that when light is passed through a sample of water, the amount of light transmitted through the sample is dependent on the amount of soil in the water. As the soil level increases, the amount of transmitted light decreases. The turbidity sensor measures the amount of transmitted light to determine the turbidity of the wash water. It is connected to channel 2 of ADC(MCP3008).

5) MCP 3008 (ADC)

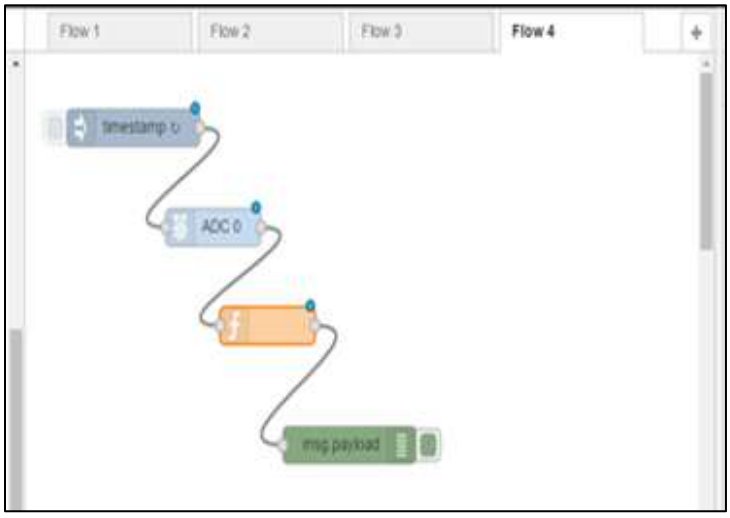


To connect the MCP3008 to the Raspberry Pi with a software SPI connection you need to make the following connections:

- MCP3008 VDD to Raspberry Pi 3.3V
- MCP3008 VREF to Raspberry Pi 3.3V
- MCP3008 AGND to Raspberry Pi GND
- MCP3008 DGND to Raspberry Pi GND
- MCP3008 CLK to Raspberry Pi pin 18
- MCP3008 DOUT to Raspberry Pi pin 23
- MCP3008 DIN to Raspberry Pi pin 24
- MCP3008 CS/SHDN to Raspberry Pi pin 25

C. *Raspberry Pi 3 to Node Red/cloud interface*

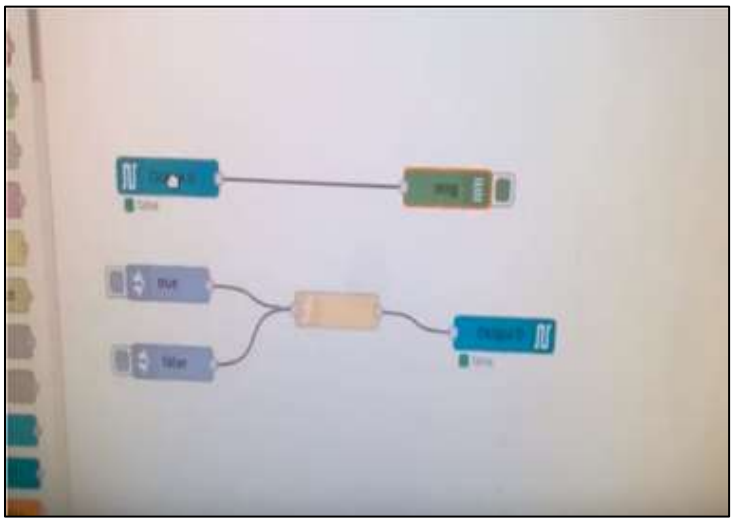
1) Start up your Raspberry Pi. Click on the Raspberry icon, then the Programming menu to open Node-RED.
2) You should see a window displaying information about Node-RED starting up.
3) Now go to the Internet menu and open Chromium Web Browser. In Chromium, locate the address bar at the top and type in localhost:1880, then press Enter. This will display the Node-RED interface.



To display temperature sensor data on Node red, we need to create Node red flow as shown in diagram below and we need to set parameters of node as per our requirement. Timestamp node is used to read sensor values every 1 second. ADC node converts sensed analog value to digital value and debug node displays the standardize value.

Similarly, pH and turbidity sensor data can be read using same node red flow diagram as used above. We need to change only channel number of ADC node to sense different sensor readings. This is how we can monitor the water quality related data on node red platform remotely.

D. Control of PLC from Node Red Webpage

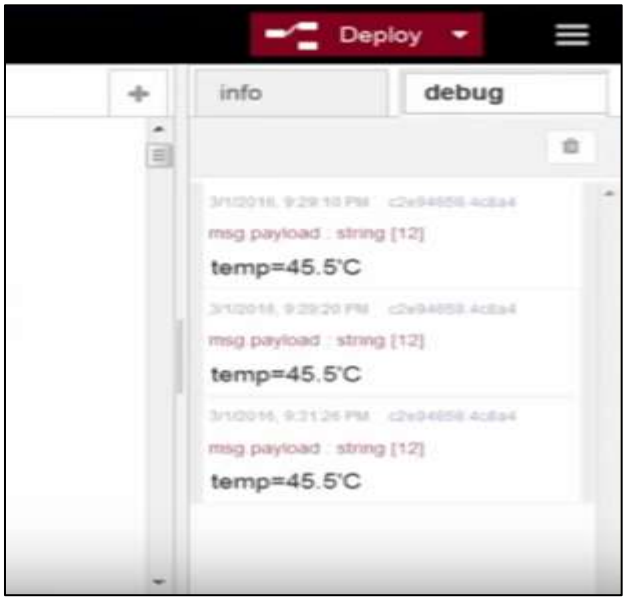


We have used S7 1200 PLC. With the help of flow diagram shown, we can control PLC output via Node red webpage. For that we need to set parameters of output node.

It includes set of parameters, such as IP address, Port, Mode and output variable. IP address is given IP address of PLC and output variable is selected as Q0.0, to which DC motor is connected using relay. True and False node in above diagram represents Logic 1(ON) and Logic 0(OFF). This is how we can control motor using node red webpage from any remote location.

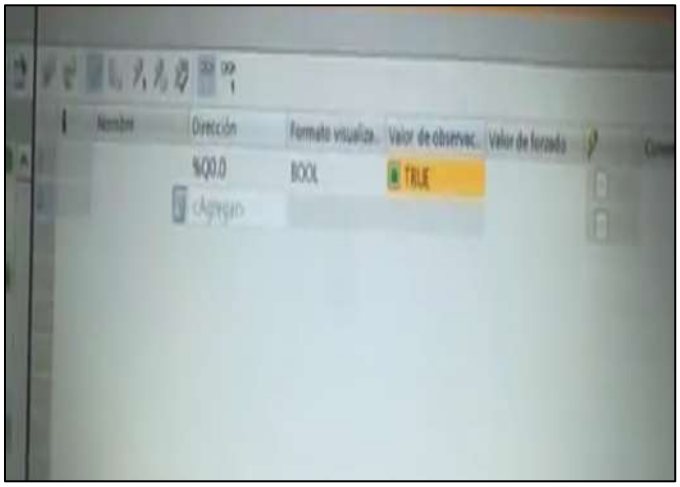
IV. RESULTS AND CONCLUSION

The sensors data is collected on node red webpage. The result of temperature data obtained on node red is shown below:



The result of controlling action taken on PLC over Node Red webpage can be observed on siemens TIA portal. At the beginning, the status of output Q0.0 is displayed as FALSE, indicating PLC output is zero that means Motor is OFF.

When TRUE node of NODE red schematic is pressed, the status of Q0.0 changes to TRUE, indicating PLC output is 1, i.e. Motor is ON



The main purpose of controlling PLC from any remote location and also monitoring of industrial parameters from any remote location is achieved, with the help of Raspberry pi board and node red interface. Just by clicking TRUE node of NODE red flow diagram, we can control PLC outputs.

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