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INDOOR AIR QUALITY MONITERING AND IMPROVEMENT USING PLC

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Abstract - *In this paper, PLC-based indoor air quality monitoring platform, consisting of an air quality sensing device and a web server is demonstrated. The device is composed of a PLC, pollutant detection sensors, fresh air fan and a WEB technology. This platform relies on PLC to control ventilation system and a WEB technology to monitor indoor air quality in anywhere and anytime. Smart-Air control has been developed by operating fresh air fan/Blower according to air quality level sensed with PLC technology to operate and control the air quality.PLC based operation of fans saves unnecessary energy wastage by continuous operation of fans as high speed when it is not needed. In the research the device was designed to measure a concentration of CO, CO2, temperature and humidity to mentor the air quality. Indoor air quality level data sensed by PLC is then transmitted to web server via FTP server in real time. A WEB page was developed to help in monitoring the air quality Also, cloud computing has been integrated into a web server for analyzing the data from the device to classify and visualize indoor air quality according to the standards from the Ministry. Thus, approved personal can monitor the air quality at any time and from anywhere, via either the web server. The web server stores all data in the cloud to provide resources for further analysis of indoor air quality*

Key Words: PLC, Indoor Air Quality, Web Technology, Fresh Air Fan, FTP Server, etc.

1. INTRODUCTION

This Indoor air pollution has been consistently ranked by the National Air Quality Monitoring Program (NAMP), System of Air Quality and Weather Forecasting and Research (SAFAR) and its Science Advisory Boards to be among the top five environmental public health risks. Average person spends an estimated 80% of their time indoors so that poor indoor air quality (IAQ) poses a substantial risk to public health. Poor air quality may cause increased short-term health problems such as fatigue and nausea as well as chronic respiratory diseases, heart disease, lung cancer and reduced work efficiency.

From above information we understood that air quality /ventilation is very important in indoor places. Air quality can be controlled by Fan /blowers but not optimized means continuous running of it will cause unnecessary energy loss because air quality varies according to time of day and people present in indoor facility.

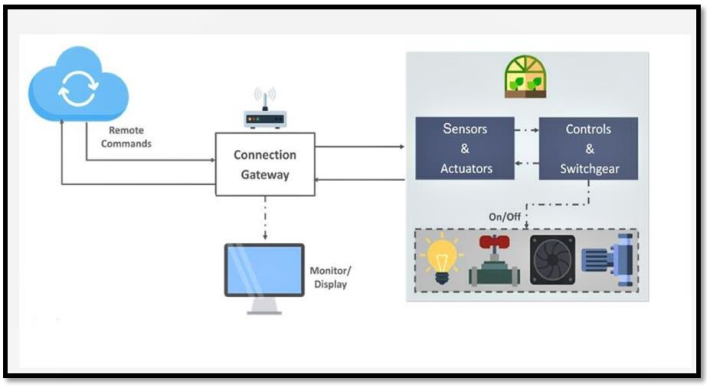

Figure 1: BLOCK DIG.

To overcome this problem and enable to monitor air quality remotely we designed a system which will control speed of fans and blowers according to real time air quality and enables us to monitor air quality level anywhere and anytime by webpage.

2. WORKING PRINCIPLE

2.1 HARDWARE PART

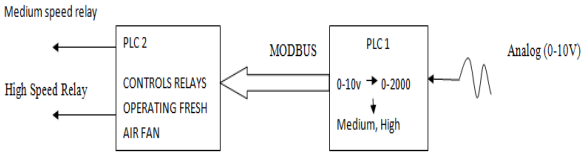

Figure 2.1.1: HARDWARE PART BLOCK DIG.

As shown in diagram above in this project we are using two PLC's. PLCs used in this project are manufactured by Renu electronics. We are using PLC's of FL004 Series. Here PLC1 takes input from CO2 sensor which is analog sensor producing 0-10 V signal which in terms of PPM is 0-2000PPM.PLC1 compares this signal with standard ranges. According to the given ranges three signals low medium and high are produced, these digital signals are transferred to PLC 2 by Modbus which will operate Fresh Air fan at desired speed according to the signals received. This will optimize the operation of Fans/Blowers according to the indoor air

condition which will avoid the unnecessary use of fans/blowers which will result in saving of electricity bill.

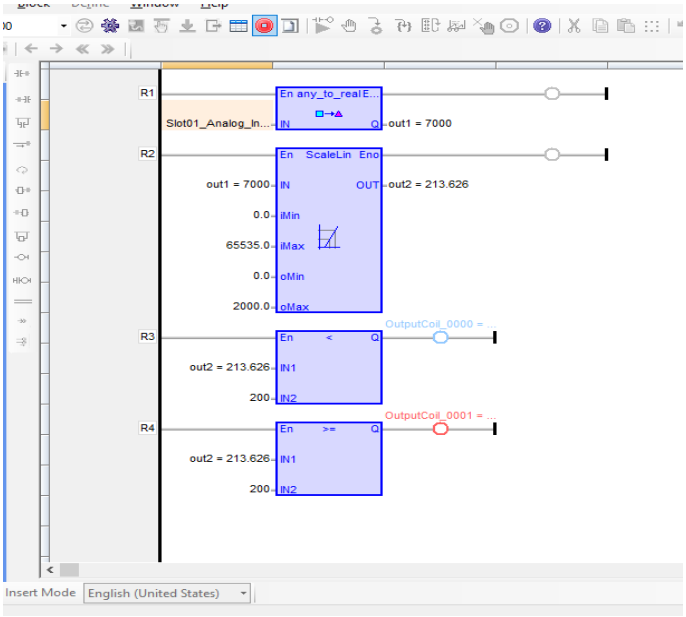

Figure 2.1.2: PLC PROGRAM

2.2 Software Part

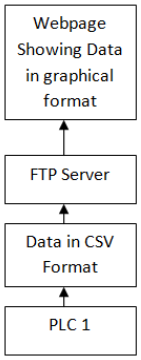

Figure 2.2.1: SOFTWARE PART FLOWCHART

Apart from scaling the signal and controlling fresh Air Fan, we are sending the real time data of PLC which is indicating CO2 level to FTP Server and we can access it from anywhere and anytime through webpage. Data from PLC is available on webpage in graphical format. Webpage is designed using JavaScript for interactivity and graph formation of data fetched from FTP server.

3. COMPONENTS

3.1 PROGRAMMABLE LOGIC CONTROLLER

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures. PLCs are used in many industries and machines. In this Project we have used Renu Electronics FL00406N PLC. It has 8digital inputs and 6 digital outputs. To measure air quality level by CO2 sensor which gives analog signal we have used additional analog module along with this PLC.

Figure 3.1: PLC (FLOO4-0806N)

3.2 CO2 SENSOR

Target gas- Carbon dioxide (CO_2)

Measurement range = 0-2000ppm_{vol}[1]

Accuracy = ±30ppm ±3% of reading

Operating Environment = Residential, commercial & industrial spaces

Operating temperature = 0-50ºc

Power supply=24VAC/VDC ±20%, 50Hz

Life expectancy = >15 years

Warm up time to spec. precision = 1min (@full specs < 15min)

High selectivity to carbon dioxide

Low power consumption

Figure 3.2: CO_2 SENSOR (eSense)

3.3 FRESH AIR FAN

Ventilation is a solution for indoor air pollution, by reducing the concentration of pollutants such and chemicals, mold spores radon, etc. The variable speeds allow choosing the amount of filtered fresh entering your home. Pushing filtered fresh air into your home helps to balance or pressurize your home relative to outside, which helps improve indoor air quality and comfort by reducing drafts. Fresh Air Fan used in this project has following properties-

Speed controllable, AC or EC motor, 230/220V, 50 Hz

Permanently lubricated, thermally protected motor

Internally mounted speed control to set required intake with high, medium, and low set points

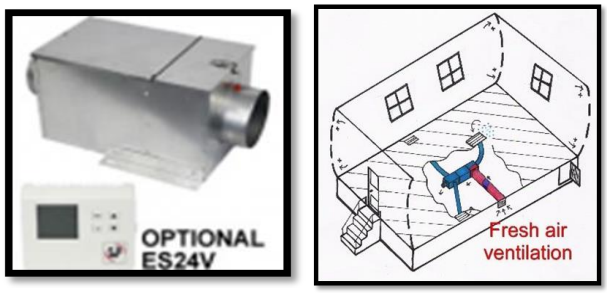

Figure 3.3: FRESH AIR FAN

3.4 SWITCH MODE POWER SUPPLY (SMPS)

SMPS is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS supplies, an SMPS transfers power from DC or AC source (often mains power power) to DC loads, such as a personal computer, while converting voltage and current characteristics. A SMPS transfer's power from DC to AC source often mains power to DC loads, such as for PLC, HMI, PCB. In this project SMPS used is KD-LRS-100-24 having ratings- Input -100-240V AC/1.9A ,50/60HZ, Output –24V,4.5 A

Figure 3.4: SMPS

3.5 MODBUS

Modbus is a data communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices. In this project we have used Modbus to communicate between two PLC's.

Figure 3.5: MODBUS

3.6 HUMAN-MACHINE INTERFACE (HMI)

A Human-Machine Interface (HMI) is a user interface or dashboard that connects a person to a machine, system, or device. While the term can technically be applied to any screen that allows a user to interact with a device, HMI is most commonly used in the context of an industrial process.

In industrial settings, HMIs can be used to:

[1] Visually display data

[2] Track production time, trends, and tags

[3] Oversee KPIs

[4] Monitor machine inputs and outputs and more

Figure 3.6: HMI

HMIs come in a variety of forms, from built-in screens on machines, to computer monitors, to tablets, but regardless of their format or which term you use to refer to them, their purpose is to provide insight into mechanical performance and progress. In this project we have used HMI manufactured by Renu electronics which not provides us user interface but also, we get real time data in csv format from HMI which we will show it on webpage in real time through FTP server.

4. CONCLUSIONS

The proposed system can be applied to periodical or real time monitoring of the concentration of carbon dioxide in the air in offices, schools and kindergartens, in residential buildings, greenhouses, transport, etc., to prevent negative consequences in the human body.using co2 sensors for DCV (demand control ventilation) was found to reduce energy consumption by 62% when compared with a constant air volume (CAV) ventilation system excessive ventilation rates have been brought under control and energy has been saved. With the help of plc, we are able to successfully optimise performance of fresh air fan to not only maintain air quality but also reduce energy consumption. Addition of web technology help us to access data from anywhere in the world

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