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Digitalized Cyber Physical System for Environmental Monitoring

Kavya P[1], Mrinal N[2], Vishnuvardhan G[3], Harshitha M[4] and Neela A G[5]
Dept. of E&IE, JSSATE, Bengaluru
[1]Kavyapswamy17@gmail.com, [2]mmrinal68@gmail.com
[5]neela8886@gmail.com

***Abstract*— This paper demonstrates the improvement of a IOT based system that supervises the environmental parameters in indoor spaces at remote locations. The IOT is the existent wireless infrastructure used as a communication between the system components. The results which we obtained helps in logging measurements from the remote areas across the world analyzing the collected data graphically using the devices which are connected to the internet. This work includes the complete solution, a IOT based solution consisting of sensors and communication protocol and collecting the data and storing data at cyber level. The experimental results exhibits that the propose system represents straight forward solution for environmental monitoring applications.**

***Index Terms*— Cyber physical.system, environmental.parameters, ambient monitoring, remote areas, IOT.monitoring.**

I. INTRODUCTION

The monitoring of environmental parameters is unquestionable in our age. In this field where wireless sensor networks (WSNs) are used first.WSNs are large .networks .of resource constrained .sensors with processing and wireless communication .capabilities, which implement different .application objectives within a specific sensing field. WSNs are also used for ambient .monitoring. [1]
This paper presents a complete system for ambient parameter and environmental monitoring using low power WSNs connected to the internet, which will send their measured data to a central server using the IOT platform. Finally the data measured from all over the world, stored on a base station, which can be envisioned from all devices connected to the Internet. This method of using WSNs overcomes the problem of system integration which simplifies .the transmission .of data .from sensors with the help of will defined architecture and increases monitoring efficiency. Wi-Fi technology was not used in implementing wireless sensing solution because of major drawback of energy consumption. By the use of this technology Wi-Fi devices can be implemented with new solution that consists of several advantages like reduction of infrastructure costs, native IP-network compatibility, high transmission rates, which are helpful in industries.

II. RELATED WORK AND CONTRIBUTION

The automated irrigated system uses this wireless networks of soil moisture and temperature sensors that aims at water savings of 90% when compared with traditional implementations.[2] The acquisition of

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heterogeneous sensors, higher reliability levels, and higher sampling rates has been developed. These proposed solutions are based on ZigBeeapplications, and under relay on gateways when the data has to be sent to the internet. Additional applications has to be developed in these cases for encapsulating data protocols like transmission control protocol(TCP) . For sending the data to the internet WI-FI sensors are directly connected to the existing IOT infrastructures is better and also less expensive. This is advantageous in indoor spaces and urban areas.
The main contribution consists in improvement of a low cost , stand- alone, dependable and low power system, with reduced total cost , which allows picturing of environmental and data where network exists. In this paper a ubiquitous network architecture is presented. Here the sensors are the part of the network. A cyber physical system involves developed WI-FI sensors and the cloud platform, which allows to access the data from every place where a network exists and it is visualized from every station which is linked to the internet, which does not include any extra hardware and software application except internet browser.

III. Wireless Sensors in Cyber Physical System

The development of sensors are continuously becoming more powerful, smaller and cheaper, which uses advances in information communication technologies and embedded systems[3]. These system provides advances over wired sensor applications, which mainly reduces the price and generalization through the exclusion of wires. These facts encourage the adoption of wireless sensor networks. The new demands and the opportunities for the use of WSNs, the combination of advanced sensing, process control, which has wide range of applications like transportation, smart buildings, manufacturing, production and others are developed in CPSs.

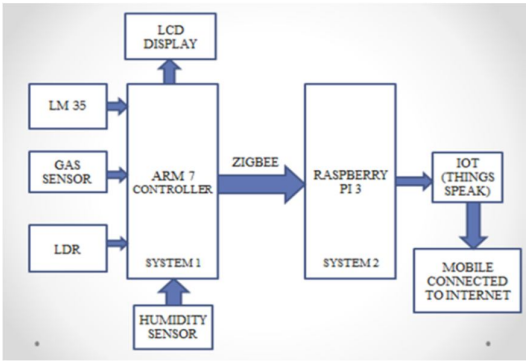

Fig1. Block diagram of this method

A definition of CPSs states that it integrates communication, computing and storage capabilities with control in physical world and it must be regularly, efficiently, safety, securely and in real time. CPSs can also be defined as, information and communication technology system, interconnected including through internet and provides a wide range of innovative applications and service. A strong relationship between cybernetic and physical resources which should outstrip ICT systems were defined in all the above definitions, in terms of efficiency, flexibility, and usability. By considering all the above definitions, this paper represents a cyber physical system which includes wireless sensors for collecting and presenting data about environment. This platform allows humans and items to be associated with anytime, wherever, whatsoever and everybody. The advantages uses of wireless sensor, which are connected directly to the internet.

IV. System Architecture

A. General Overview

A block diagram illustration of cyber physical system used for discerning the environment in interior and open-air spaces, where wireless sensor network exposure exists is as shown in fig 1.[4]
The two main system components involves of the following

- WIFI sensors: low power wireless sensors like temperature, light intensity, humidity, CO2 are used.
- IOT platform: An raspberry pi 3 model B controller running the server application.

V. WI-FI SENSORS

A. Temperature Sensor

The LM35 consists of two independent, high gain, internally frequency-designed specifically operational amplifiers to operate from a single power supply over a wide range of voltages. The functioning temperature range is from -55°C to 150°C.With LM35, accurate measurement of temperature is possible. LM35 is reasonable; it is available at low price.

In order to detect temperature of a particular region, temperature sensor is used. This sensor senses the temperature change in particular region and provides an output signal voltage. The detected change in temperature in degree Celsius/ Fahrenheit is displayed on LCD. Analog to digital output conversion is done using arm7.

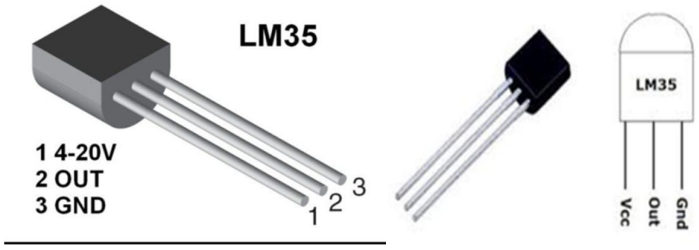

Fig 2. Temperature sensor

B. Gassensor

In this method we are using gas sensor to detect carbon-di-oxide level. Atmosphere consists of many gases like carbon monoxide , nitrogen , oxygen etc. The gas sensor is programmed to molecular weight of carbon-di-oxide so that it can only detect its value.The gas sensor is used to sense gas level like Co2, smoke levels. It has a comparator and a potentiometer. This comparator compares the obtained voltage with the reference voltage. They are used in gas leakage detecting equipment in house and industry. They are fit for spotting of LPG, natural gas, town gas. They avoid the noise and cooking fumes and cigarette smoke, and the related output is displayed LCD.[5]

Symbol	Parameter name	Technical condition
Vc	Circuit voltage	5V±0.1
V_H	Heating voltage	5V±0.1
P_L	Load resistance	20KΩ
R_H	Heater resistance	31±10%
P_H	Heating consumption	less than 800mw

Fig 3. Gas sensor

C. Light IntensitySensor

A light controlled variable resistor is calledphoto resistor or light dependent resistor .when light intensity falls on it its resistance changes. Resistance is inversely proportional to light.Photoconductivity is the principle on which LDR works. Photoconductivity is an optical phenomenon in which materials conductivity reduces when light is absorbed by the material. When the light falls on the device, the electrons of the semiconductor materials are excited. The applications of LDR are Camera Exposure Control, Auto Slide Focus - dual cell, Photocopy Machines - density of toner, Colorimetric Test Equipment, Densitometer.[6]

D. Humidity Sensor

It measures and report the relative humidity in the air. It measures both moisture and air temperature. Electrical capacitance is the ability of two nearby electrical conductors to create an electrical field between them. The voltage changes are converted into digital readings showing the level of moisture in air. The deeper the air temperature is the more humidity it can hold. It can be used as a monitoring and preventing measures in homes for illness.

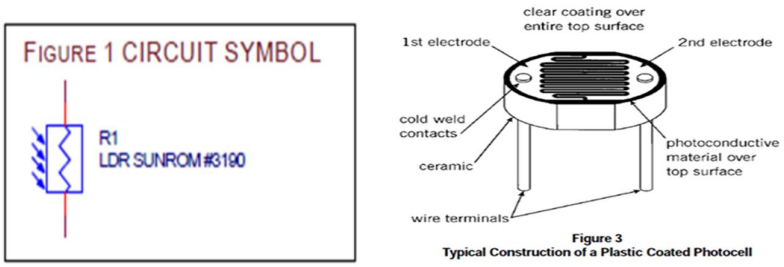

Fig 4. Light Intensity sensor

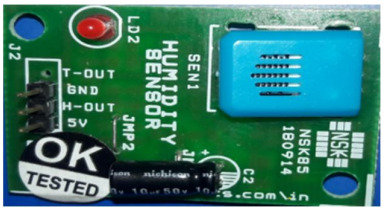

Fig 5: Humidity sensor

The applications of humidity sensors are, Climate control for green houses, Office automation , Room comfort control, Automotive cabin air control, Medical applications, Home appliances , air conditioners.

VI. HARDWARE INTERFACING

A. ARM 7 Controller

The ARM is a 32-bit reduced instruction set computer (RISC) instruction set architecture (ISA)developed by ARM Holdings. ARM also known as Advance RISC Machine. The ARM featured a 32-bit data bus, a 26-bit address space and thirty-seven 32-bit registers. The relative simplicity of ARM processors makes them suitable for low power applications. ARM processors developed by licensees include DEC Strong ARM, Free scale i.MX, Marvell (formerly Intel) XScale,NvidiaTegra, ST-Ericsson Nova.Features of ARM 7 include, ARM has 37 registers all of which are 32-bits long[7]

- 64 KB on-chip Static RAM.
- 128 KB on-chip Flash Program Memory.
- Up to thirty-two 5 V tolerant general-purpose I/O pins .
- 60 MHz maximum CPU Clock available from programmable on-chip.
- On-chip crystal oscillator with and operating range of 1 MHz to 30 MHz .
- Two low power modes: Idle and Power-down.

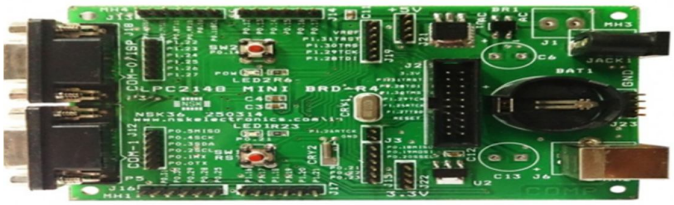

Fig 6. ARM 7 controller

B. Raspberry pi 3 Model B

Raspberry is a 40 pin extended GPIO kit. This is more durable and it is used to transfer data to the cloud. It can be interfaced with any devices for extended solution. It consists of micro USB power input. And it consists of micro SD card slot for inserting SD card to store data. Raspberry pi 3 model B consists of a on board Bluetooth WI-FI which helps in transfer of data to the other devices and on to IOT platform. It consists

of a full size HDMI video output which is used to analog data to digital output. It also consists of a LAN port , 4x USB 2 ports, CSI camera port, DSI display port. This raspberry is of dimension as mentioned in figure above. [8]

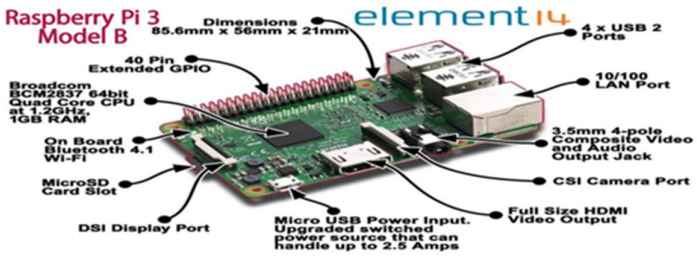

Fig 7. Raspberry pi 3

VII. INTERFACING

Temperature sensor, senses any temperature variations in atmosphere, sensor is interfaced to the arm 7 board, the analog output is converted to digital using arm 7. The gas sensor, senses pollutant level of Co2 , CO in the atmosphere, reference is set to 5v, if output exceeds this reference this shows high, if below this show low else result will be normal. Humidity sensor is interfaced to arm 7 board, this senses moisture content in the environment, the analog output obtained is converted to digital output using this arm 7. Light intensity work on principle, resistance is inversely proportional to light incident. If light intensity is high, resistance decreases and result will be shown light(L). If light intensity is low, resistance increases and result will be shown dark (D). ZIGBEE consists of both transmitter and receiver ports. ZIGBEE transmitter is connected with arm 7, it will help in transmitting data received from sensors to raspberry pi 3. ZIGBEE receiver is connected with raspberry pi 3 which help in received data from transmitter. This received data is sent to cloud.Using things speak website a channel is created. Environmental parameters which has to be monitored is registered in that website. A tagline is given, user who has to view environmental parameters has to log in through that tagline. Then they can analysed using the devices connected to internet.[9]

VIII. RESULTS

Environmental parameters can be graphically analysed using IOT platform. Any variations in the parameters like temperature, humidity, light intensity, CO2 is automatically updated and can be analysed. People can access this data easily through the devices connected to the internet.

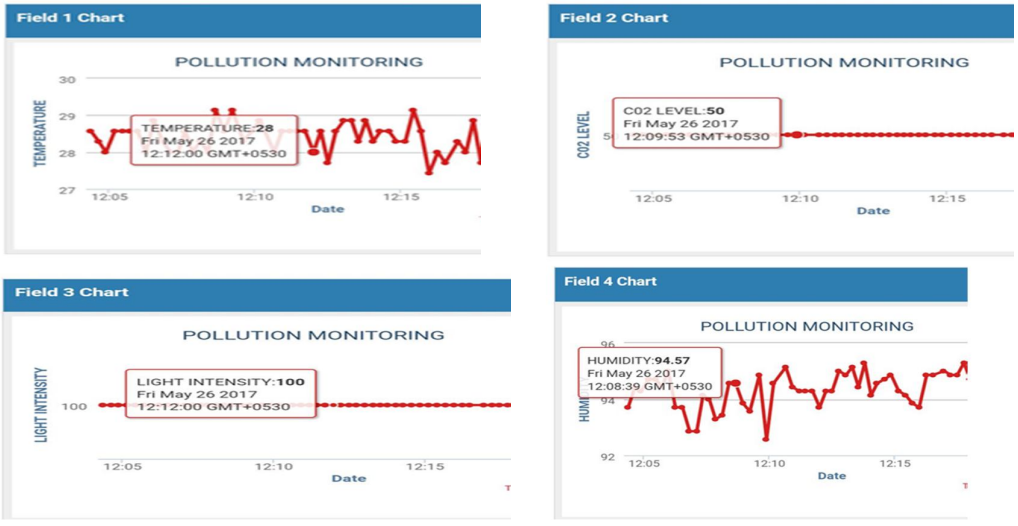

Fig 8: Graph of results

IX. Discussion

This project helps us understand environmental parameters in an easy way. People can access data through the devices connected to internet wherever they can find Wi-Fi coverage. In advance we can use pressure sensor for measurement of pressure of liquids and gases in industries. It can also use radio isotope sensors for the detection of radio active elements in the surrounding environment. This the best and simpler method for detection of environmental parameters easily. This can implemented in areas wherever monitoring of parameters is necessary.

X. Conclusion

The development of IOT based system using wireless sensors helps in monitoring environmental conditions. This type of measurement includes sensors for measuring environmental conditions and sending that data to cloud platform. The construction of protocol for communication of data and design of node architecture helps in manufacture of lower power depletion. This kind of system eliminates massive solutions, and helps in accessing of data from the areas where there exists network coverage.

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