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Review on A Cyber Physical System for Monitoring and Controlling of Industrial Pollution using Raspberry Pi

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ABSTRACT

In this paper developing of a cyber physical system that monitors the environmental conditions or the ambient conditions in indoor spaces at remote locations. The resulted solution provides the possibility of logging measurements from locations all over the world and of visualizing and analyzing the gathered data from any device connected to the Internet. This work encompasses the complete solution, a cyber-physical system, starting from the physical level, consisting of sensors and the communication protocol, and reaching data management and storage at the cyber level. The experimental results show that the proposed system represents a viable and straightforward solution for environmental and ambient monitoring applications.

Keywords : Wireless Sensor Network, Coverage , Clustering , Routing Protocol, Raspberry Pi.

I. INTRODUCTION

The importance of environmental monitoring is undoubted in our age. This is the field where wireless sensor networks (WSNs) have been first used, their primary purpose consisting in the observation of the physical world and the recording of physical quantities characterizing it. WSNs are large networks of resource-constrained sensors with processing and wireless communication capabilities, which implement different application objectives within a specific sensing field. They can also be used for ambient monitoring, a topic of great interest nowadays as well, indoor air quality representing an important factor affecting the comfort, health, and safety of building occupants. Finally, the use of wireless ambient sensors can lead to more energy-efficient buildings. The constant attempts of social and economic bodies for the development of technologies for improving energy efficiency and reducing pollution and for the more efficient use of national infrastructure along with the needs of decreasing the cost of computation, networking, and sensing had lead to the emergence of a new generation of digital systems, called cyber-physical systems (CPSs), less than a decade ago. These include embedded systems, sensor networks, actuators, coordination and management processes, and services to capture physical data and to act on the physical environment, all integrated under an intelligent decision system . In this context, wireless sensors can be used to collect physical information that is further exploited by CPSs This will lead to CPSs composed of interconnected clusters of processing elements and large-scale wired and wireless networks of sensors and actuators gathering data about and acting upon the environment These newly appeared systems have a lot of similarities with the Internet of Things (IoT), an enabler of ubiquitous sensing, that envisions a world in which many billions of Internet-connected objects or things, with sensing, communication, computing, and potentially actuating capabilities, will coexist, allowing an uninterrupted connection between people and things.. This paper presents a system for environmental and ambient parameter monitoring using low-power wireless sensors connected to the Internet, which send their measurements to central server using the IEEE 802.11 b/g standards. Finally, data from all over the world, stored on the base station, can be remotely visualized from every device connected to the Internet. This overcomes the problem of system integration and interoperability, providing a well-defined architecture that simplifies the transmission of data from sensors with different measurement capabilities and increases supervisory efficiency.

II. Literature Survey

Paper 1. ISSAQ: An integrated sensing systems for real-time indoor air quality monitoring . J.-Y. Kim, C.-H. Chu and S.-M. Shin, IEEE Sensors J.vol. 14, no. 12, pp. 4230–4244, Dec. 2014.

Observation: With growing transportation and population density, increasing global warming and sudden climate change, air quality is one of the critical measures that is needed to be monitored closely on a real-time basis in today's urban ecosystems. This paper examines the issues, infrastructure, information processing, and challenges of designing and implementing an integrated sensing system for real-time indoor air quality monitoring. The system aims to detect the level of seven gases.

Paper 2. An information framework for creating a smart city through Internet of Things. J. Jin, J. Gubbi, S. Marusic, and M. Palaniswami, IEEE Internet Things J., vol. 1, no. 2, pp. 112–121, Apr. 2014.

Observation: in his article, says “cities are the centers of innovation and the people living in them want to be connected. Most cultures around the world are at a point where they cannot live without the Internet.” Not only people, but a huge amount of other things are now connected to the Internet, and such a network of connected things underlies the grounds upon which smart cities emerge. The Internet of Things (IoT) thus naturally becomes the nerve center giving life to smart cities and opens up a vast road of promising potentials for innovation. They present an elucidative discussion on aspects concerning the viable implementation of urban IoT, such as enabling technologies, protocols, and architectures. Putting citizens as the central concern of the smartification process. Authors approach their solution design from the sensory level, network structure, data management, and cloud-based integration of services, detailing on the building blocks of a smart city IoT infrastructure. A smart city scenario that horizontally connects several application domains, namely smart health, smart home, smart living, smart transportation, and public safety is used for illustration purposes.

Paper 3. IoT enabled proactive indoor air quality monitoring system for sustainable health management. M.F.M Firdhous, B.H Sudantha, P.M Karunaratne. 2017 Second International Conference On Computing and Communications Technologies (ICCCT’17)

Observation. In this paper recent times indoor air quality has attracted the attention of policy makers and researchers as an important similar to that of external air pollution. In certain sense, indoor air quality must be paid more attention than outdoor air quality as people spend more time indoors than outdoors. These emissions contain many substances that are harmful to human health, when exposed to them for a prolonged period of time or more than certain levels of concentration. The IoT device has been programmed to collect and transmit data at an interval of five minutes over blue tooth connection to a gateway node that in turn communicates with the processing node via the WiFi local area network.

Paper 4. IoT based air pollution monitoring and predictor

system on Beagle Bone Black. Nitin Sadashiv Desai, John Sahaya Rani Alex. 2017 International Conference on Nextgen Electronic Technologies.

Observation. Urban air pollution rate has grown to alarming state across the India. Most of the cities are facing issue of poor air quality which fails to meet standards of air for good health. It is indeed necessary to develop an air pollution measurement and prediction system for a smart city. This proposed work acquires carbon dioxide and carbon monoxide level in the air along with Global Positioning System (GPS) location by using pollution detection sensor and uploads into Azure cloud services. Low cost embedded Beagle bone board along with gas sensors are used for data acquisition.

Paper 5 IoT Based Air Pollution Monitoring System Riteeka Nayak1, Malaya Ranjan Panigrahy, Vivek Kumar Rai. Imperial Journal of Interdisciplinary Research (IJIR) Vol-3,Issue-4,2017ISSN2454-1362, Imperial Journal of Interdisciplinary Research (IJIR) Page 571

observation: In this paper we are going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will trigger a alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2, smoke. It will show the air quality in PPM on the LCD and as well as on webpage so that we can monitor it very easily. We have used MQ135 sensor which is the best choice for monitoring Air Quality as it can detects most harmful gases and can measure their amount accurately.

Paper 6. Air and Sound Pollution Monitoring System using IoT . Ms. Sarika Deshmukh, Mr . Saurabh Surendran , Prof. M.P. Sardey. 6 International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 5 Issue: 6 175 – 178 - 175 IJRITCC | June 2017.

Obervation. This paper is able to provide a mechanism for the operations of the devices to do better in monitoring stage. This monitored data can be obtained from remote location without actually visiting it due to the access of internet. The framework of this monitoring system is based on combination or collaboration of affective distributed sensing units and information system for data composition. The role of IoT is the new concept used in air and sound pollution measurement, which allows data access from remote locations.

III. Principle and Work

The advances in embedded systems and information communication technologies had led to the development of sensors, which are continuously getting more powerful, smaller, and cheaper. These offer a range of advances over traditional wired sensor applications, the most important consisting in the cost reduction and simplification of deployment through the elimination of wires. All the aforementioned facts encourage the adoption of wireless sensor networks at a scale never encountered before and it is expected that in the future, this trend will not only continue but also become even more accentuated. Furthermore, the development of CPSs brought new demands and opportunities for the use of WSNs, the combination of advanced sensing, measurement and process control having applicability across a wide range of domains, such as transportation, energy, civil infrastructure, environmental monitoring, defense, smart buildings, manufacturing and production, and others.

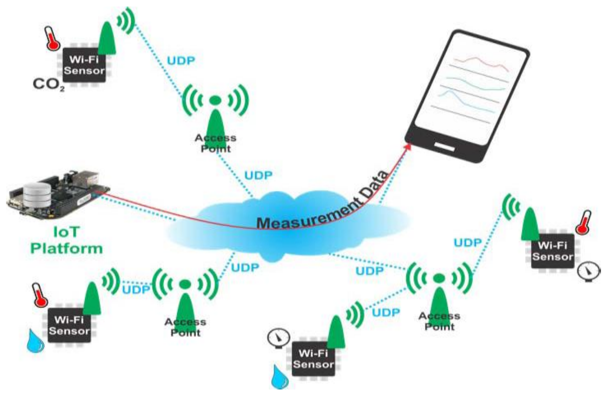

Fig.1.A graphical representation of the entire CPS used for monitoring the environment in indoor or outdoor spaces.

The two main system components consist of the following.

1) Wi-Fi Sensors: Low-power wireless sensors based on the programmable system-on-chip 3 (PSoC on the RN-131C/G wireless local area network (WLAN) module .

IoT Platform: A Raspberry pi embedded computer running the server application. The detailed description of the hardware and software of the two system components will be given in the remainder of the section.

1) Node Architecture: The Wi-Fi sensors are represented by low-power multifunctional devices, having the three basic capabilities encountered in wireless sensor nodes, which consist in sensing, data processing, and communication. Several models of the Wi-Fi sensors were developed, employing the RN-131C/G WLAN module, using two main architectures: one in which the Wi-Fi module is used at its full potential being the central part of the node, and the other one in which an external processor is used for controlling the RN-131C/G component through serial commands sent over Universal Asynchronous Receiver/Transmitter (UART).

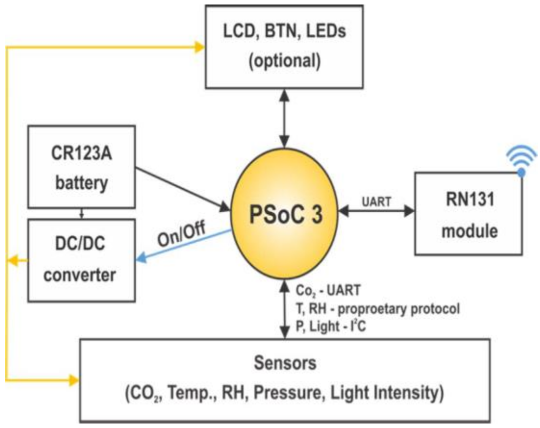

Fig.2.The embedded application stack of the devices using the architecture .

The Embedded Configurable Operating System (eCos) operating system and the services provided by the software development kit for specifying the measurement and communication actions . The sensors that can be attached to the node measure the temperature (analog—PT1000 and digital— DS18B20. or temperature and relative humidity.. While the PT1000 sensor is read through an analog input, the protocols implemented by the WLAN module for communicating with the digital sensors are 1-Wire for the DS18B20 sensor and a proprietary protocol for the DHT22 sensor. The measurement application running on the node starts at predefined time intervals, performs the measurements, sends the recordings, and goes back to sleep for minimizing the power consumption. Depending on the sensor attached to the device, different ranges for the temperatures are available. The use of the WLAN module as the central processing component of the node reduced the communication latency and costs for the node, but the need of adding other sensors communicating on different protocols lead to the development of a second architecture, This second architecture is based on a ARM7. programmable system on-chip microcontroller produced by Cypress Semiconductor, the part that initiates all the actions performed by the wireless node. The devices in this category can measure CO2 (carbon dioxide) levels, temperatures, and the relative humidity in the air, the absolute pressure, and the light intensity using the following digital sensors: a Cozir ambient sensor, a DHT22, an MPL115A2 barometer and a TSL2561, respectively. These sensors can appear in any combination attached to a Wi-Fi device, with or without an LCD for the local visualization of the measured values. The communication with each one of the components is performed through using different protocols: serial data transmission for the carbon dioxide sensor and for the Wi-Fi module, a proprietary protocol for the DHT22 sensor, and I2C with the barometric pressure and light sensors.

2) Configuration and Operation: All the developed sensors, built using either one of the two architectures, have the same lithium CR123A 3 V battery as the power supply and transmit data through the same protocol, the only difference consisting in the configuration mode, which uses different menus. However, the procedure is similar and it is performed through the serial interface using an RS232 cable and a telnet client. The menus allow the specification and the display of the parameters required for the proper operation of the wireless sensors, namely, the period between measurements, which can be set to have a value between several seconds and 60 min; the information for connecting to WLANs, namely, the channel used, the Service Set Identifier, and passwords; the data server information, which includes the server port and the IP; the node IP; the gateway and the subnet mask, which are important in the case in which data is sent outside the local area network (LAN) to which the sensor is connected; and the CO2 sensor's configuration, if this

is present in the design. The presence of the carbon dioxide sensor significantly affects the design of the device's hardware and software components, requiring the use of a separate power supply, a dc/dc converter, in the case of the model based on the PSoC 3 device. The carbon dioxide non-dispersive infrared sensor requires special routines for calibration also and additional recordings in the menu are added for setting the parameters of different types of supported calibration routines: auto calibration, calibration using a gas containing no CO2, calibration using a known gas concentration, and calibration using fresh air. The calibration routine for non-dispersive infrared carbon dioxide sensors has to compensate for the sensor drift that appears after long operation times. It implies the addition of an offset value to all readings. This is computed as the difference between the readings when a sensor is exposed to a known gas concentration and the original calibration value and is performed through sensor specific commands issued by the core microcontroller. These types of sensors also require a warm-up period, which significantly affects the power consumption of the device. This is proportional to the digital filter that can be set to a value between 2 and 32 instant measurements for attenuating the noise in the carbon dioxide level readings. Besides the CO2 sensor and the PT1000 probe, no other sensor requires calibration actions, this being performed at the factory. The entire system is a duty-cycled one, so the components are powered only for short periods of time, depending on the action they perform and on the period between measurements set by the user. This communication between the two is performed through the UART using an advanced application programming interface software, called WiFi, Here, the RN-131C/G module automatically connects to a specific access point and acts as a pipe, sending serial information over UDP, after being powered. This is the reason why these aspects were not approached until now, only standard WPA2 (Wi-Fi Protected Access II) encryption or the security protocol in the wireless computer network to which the sensor node is connected is used.

IV. 4. CONCLUSIONS

In this paper encompasses the complete solution, a cyber-physical system, starting from the physical level, consisting of sensors and the communication protocol, and reaching data management and storage at the cyber level. The experimental results show that the proposed system represents a viable and straightforward solution for environmental and ambient monitoring applications

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