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Environmental Monitoring Using Robotics

Ann Mary Antony[1], Aswini S[2], Anjaly P O[3], Bibin M Mathew[4], Dr. K. Karunakaran Nair[5]

UG Scholars, Department of Electronics and Communication Engineering, Amal Jyothi College of Engineering, Kanjirappally, India[1, 2, 3, 4]

Professor, Department of Electronics and Communication Engineering, Amal Jyothi College of Engineering, Kanjirappally, India[5]

Abstract: Robotic systems are increasingly being utilized as fundamental data-gathering tools by scientists, allowing a new perspective and a greater understanding of the planet and its environmental processes. This paper discusses the design of a robotic platform within a wireless sensor network to monitor the environmental changes. The system includes various sensors for measuring temperature, pressure, humidity and light intensity in an environment. The wireless transceiver mounted on the robot sends the collected data simultaneously to the PC, which enables long distance communication. The obstacle detector robot can be controlled by giving commands through PC. It also consists of a sensor for detecting the presence of different gases like methane, CO, alcohol, propane and LPG.

Index Terms: Robotics, Sensors, Arduino Uno, Wireless Transceiver.

I. INTRODUCTION

Robotics science has made huge progresses since the arrival of the first commercial robots on the factory floor more than fifty years ago. Principally, robots have received new and better sensors, along with algorithms that provide the means to perceive their operating environment and plan missions autonomously while reacting to various uncertainties. Nowadays, robots can be seen operating in natural or in man-made, highly unstructured environments. The main components of the system are Arduino Uno, PC, various sensors and wireless transceiver. The robot is embedded with an obstacle finding sensor. The robotic platform selected for this project is ATmega328P microcontroller with Arduino and programmed using Embedded C. The mobile robot is able to move inside the test area by avoiding obstacles. A buzzer will be activated to indicate the presence of obstacles. Robots sense the environmental data and send to PC using wireless transceiver.

II. BLOCK DIAGRAM

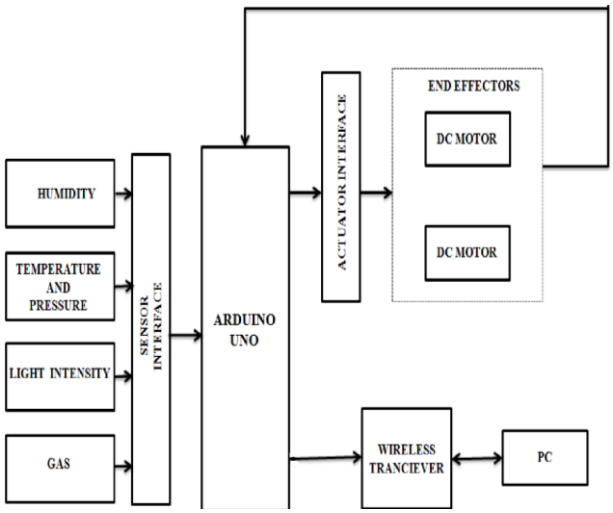

Fig 1: Block Diagram of the proposed system.

The proposed system consists of mainly two sections, the Sensor section for monitoring the environment and the Transceiver section. The former section includes humidity sensor, pressure sensor, and temperature sensor, light intensity sensor and gas sensor whereas the latter section consists of an Xbee module. The Arduino Uno is a microcontroller board based on the ATmega328P. L293D is a typical motor driver IC which allows DC motor to drive on either direction. The ultrasonic ranging module, HC-SR04, is a proximity/distance sensor that has been used mainly for object avoidance. It provides 2 cm to 400 cm non-contact measurement function. Xbee module allows an Arduino board to communicate wirelessly using Zigbee.

III. SYSTEM DESCRIPTION

Environmental Monitoring Robot is a system developed in ATmega328P platform. The various sensors mounted on the chassis sense the environmental parameters in the test environment and the collected data is received on a PC using Xbee wireless transceiver. The commands given through the Xbee module will direct the robot in the test environment. In addition to the environmental monitoring sensors, a gas sensor module is also embedded to detect gas leakages in home and industries. Since the robot is made as an obstacle detector, it will avoid obstacles and move according to the commands given by the user through wireless transceiver.

A. Robotics

Robotics deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, and or cognition. Robots can augment the capabilities of sensor networks since they can carry larger loads and hence a wide range of sensors and collect dense measurements. They can operate autonomously and sample the environment in an adaptive fashion. They can also interact with stationary sensors by

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improving their connectivity. They can even deploy, relocate and recharge stationary sensors.

B. Sensors

A sensor is an object whose purpose is to detect events or changes in its environment, and then provide a corresponding output. A sensor is a type of transducer, which provides various types of outputs. The various sensors used for environmental monitoring are DHT11, for humidity measurement, BMP180, for temperature and pressure measurement, LDR, for light intensity measurement and MQ2, for gas detection. DHT11 digital temperature and humidity sensor is a composite sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement device, and connected with a high performance 8-bit microcontroller. BMP180 is a barometric pressure sensor which measures the absolute pressure and temperature of the air around it. This pressure varies with both the altitude, and any other tasks that require an accurate pressure reading. LDR is a light controlled variable resistor whose resistance decreases with increase in incident light intensity. MQ2 gas sensor module is useful for gas leakage detection in home and industry. It is suitable for detecting hydrogen, LPG, methane, carbon monoxide, alcohol, smoke or propane. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible and sensitivity can be adjusted by using the potentiometer.

C. Arduino Uno

The Uno is a microcontroller based on the ATmega328P. It has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable to power it with an AC-to-DC adapter or battery to get started. Uno can be programmed with the Arduino software. The ATmega328P on the Uno comes programmed with a boot loader that allows uploading new code without the use of an external hardware programmer.

D. Wireless Transceiver

Xbee baseboard USB interfacing board used to interface ZigBee wireless module with desktop or laptop computer system. User can use this interfacing board to connect raw module of ZigBee to make communication between PC to PC, PC to mechanical assembly, PC to embedded and microcontroller based circuits. User can also use this board to configure ZigBee (Xbee) according to application. As ZigBee communicates through serial communication, the other end of USB which is connected to PC treated as COM port for serial communication. User can use any type of ZigBee module almost. It is provided with indication LED's for ease. ZigBee hardware typically consists of an 8-bit microcontroller combined with a miniature transceiver, a small amount of flash memory and RAM. The Xbee module is interconnected with the 8-bit microcontroller. The CMOS logic is used between the microcontroller and Xbee module, the information is transmitted and received using ZigBee.

IV. EXPERIMENTAL RESULTS

The whole system is placed in a test environment as shown in figure .1. The embedded sensors in the robot allow the close monitoring of environmental parameters and provide minimal noise, accurate data to the wireless sensor network.

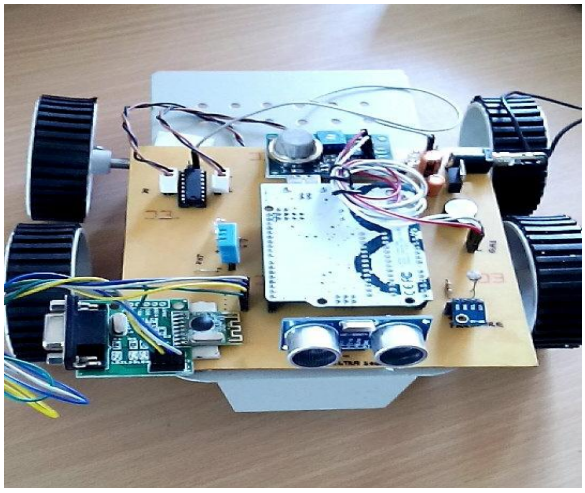

Fig.1 Environmental monitoring robot

The sensed data is viewed in a PC using the software PuTTY, open source software that is available with source code. The observed results are shown in figure.2. The environmental parameters of the test environment are measured using standard calibrated devices and the results are tabulated as shown in the table.1.

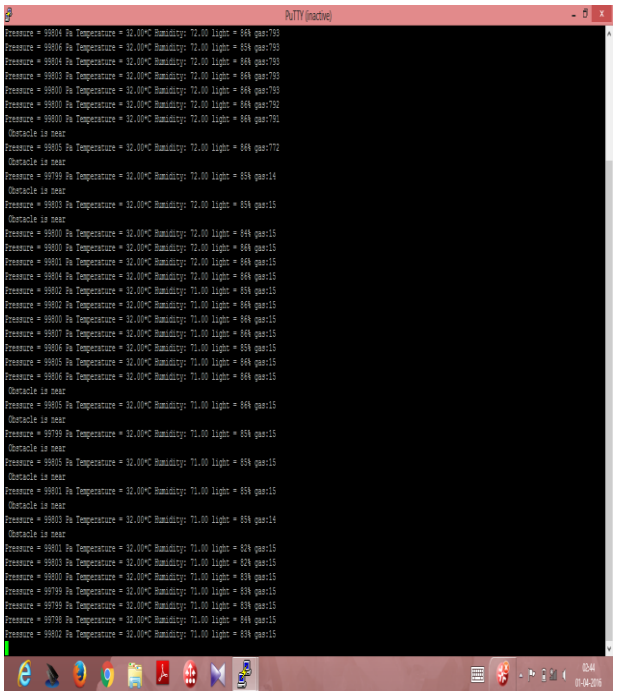

Fig. 2 Observed results

Table 1 Compared results

Sl. No	Environmental parameters	Proposed system result	Standard device result
1	Temperature	32°C	32.3°C
2	Pressure	99800 Pa	99806 Pa
3	Humidity	72	73.1
4	Light Intensity	86%	88%

V. CONCLUSION AND FUTURE WORK

This paper presents the design and implementation of an Environmental Monitoring Robot in ATmega328P platform. The system monitors the environmental conditions of a test area as an alternative to the application of a network of fixed environmental sensors. The robot uses onboard sensors to obtain temperature, pressure, humidity and light intensity in order to analyze the ambient conditions. With the help of robotic platform the wireless sensor network senses useful information and provides real time streaming of the environment. From the table .1, it is clear that the proposed system is accurate.

Future works will be focused on mounting a camera on the robot and their by monitor adverse environmental conditions. Also by replacing the wireless transceiver module with wifi module, we can enhance the data accessing capability.

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