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# AIR QUALITY MONITORING SYSTEM WITHIN CAMPUS BY USING WIRELESS SENSOR

**[1]MR.G.HARISH KUMAR, [2]JILLALA SRUTHI, [3]K.AKSHAYA, [4]G.NITHEESHA**
[1]Assistant Professor, Department of Electronics and Communication Engineering,**MALLA REDDY ENGINEERING COLLEGE FOR WOMEN,** Maisammaguda, Dhulapally Kompally, Medchal Rd, M, Secunderabad, Telangana.
[2,3,4]Student, Department of Electronics and Communication Engineering,**MALLA REDDY ENGINEERING COLLEGE FOR WOMEN,** Maisammaguda, Dhulapally Kompally, Medchal Rd, M, Secunderabad, Telangana.

**ABSTRACT** __This paper presents a solution for monitoring CO2 emissions produced by vehicles on a university campus using distributed sensor nodes and ZigBee technology. Sensors were strategically placed along main streets to track CO2 concentrations. The data revealed that speed bumps contribute to higher CO2 emissions from vehicles. Our findings indicate that CO2 levels on the campus are at 410 parts per million, which is within acceptable limits. The developed wireless system has proven effective in taking actions to mitigate environmental pollution by suggesting the removal of speed bumps or restricting vehicle circulation during peak hours when pollution levels are elevated.

## I.INTRODUCTION

Since the Industrial Revolution, atmospheric CO2 levels have risen significantly, increasing by at least 30% since 1975. This rise contributes to greenhouse gas effects and global warming, with CO2 accounting for approximately 64% of greenhouse gases [1]. Despite awareness of climate change, the impacts of pollution often go unnoticed, leading to inadequate preventive measures. Globally, about 24,000 million tonnes of CO2 are emitted annually, with the OECD countries contributing 52%, Russia 14%, and China 13%. The United States emits approximately 5,500 million tonnes, about a quarter of the global total, while Latin America, including Mexico, contributes about 1% [2]. According to the World Health Organization (WHO), 2.7 million people die annually due to CO2-related health issues [3]. Previous studies have focused on CO2 monitoring indoors [4-6] or in vehicle-related scenarios [7-8], but our work utilizes open-source equipment to develop a real-time wireless monitoring system using ZigBee technology. This system aims to evaluate vehicle-generated CO2 levels on campus, identify high-emission periods, and suggest actions to mitigate pollution.

## II.LITERATURE SURVEY

The Internet of Things (IoT) is a network of interconnected physical devices, including computing systems, mechanical and digital machines, and objects that can transmit data over networks without human intervention (Margaret Rouse, 2020). IoT extends beyond traditional computer networks to encompass a wide array of devices, such as cars, smartphones, home appliances, and industrial equipment, all communicating

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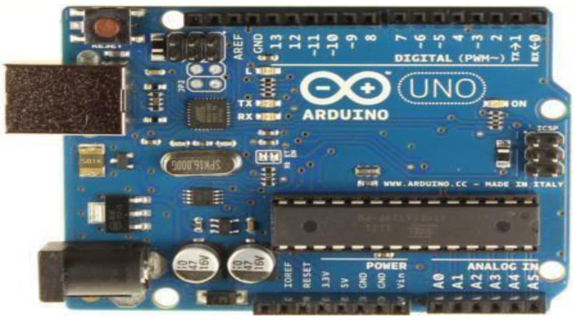
based on specific protocols to achieve smart functionalities (Keyur Patel, 2016). For example, the management of dams, which is critical due to their use for hydroelectric power and irrigation, can benefit from IoT integration. Current manual supervision of dams introduces risks and delays in decision-making. To address this, a Disaster Monitoring and Management Framework for dams using IoT is proposed. This framework employs sensors to collect data from the environment and the dam itself. A microcontroller processes this data and manages the system automatically, reducing design and control complexity, and



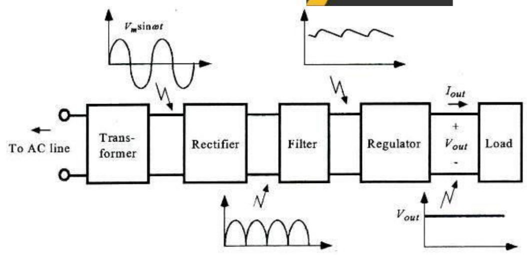
facilitating timely decision-making via a web portal (Kavitha, 2021).

## III. DESIGN OF HARDWARE

This chapter provides an overview of the hardware components used in the project, detailing the circuit diagram and functionality of each module.

### Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 chip. It features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. This board is designed to support the ATmega328 microcontroller, which can be powered either through a USB




Components of a typical linear power supply

connection or an AC-to-DC adapter. Unlike previous Arduino boards, the Uno uses the Atmega16U2 (previously Atmega8U2) as a USB-to-serial converter, eliminating the need for an FTDI USB-to-serial driver chip.

Key features of the Arduino Uno include:

- **1.0 Pin Out**: Added SDA and SCL pins for I2C communication, and IOREF pin to accommodate different voltage levels.
- **Stronger RESET Circuit**: Improved reset functionality.
- **New USB-to-Serial Converter**: Replacement of the Atmega8U2 with Atmega16U2.

The "Uno" signifies the board's role as the reference model for Arduino version 1.0 and future Arduino releases.

*Fig: Arduino Uno*

### Power Supply

The power supply unit converts high-voltage AC mains electricity into a stable low-voltage DC supply suitable for electronic circuits. A regulated DC power supply ensures a constant output voltage despite fluctuations in the AC mains or variations in load. It typically consists of several components, including a transformer, rectifier, filter, and regulator, each performing specific functions to provide a stable power output.

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*Fig: Block Diagram of Power Supply*

**LCD Display**

The LCD display module used is based on the HD44780 microcontroller, a popular choice for its affordability and functionality. This module supports displaying messages on two lines with up to 16 characters per line. It is capable of showing letters, numbers, punctuation marks, and custom symbols. Useful features include automatic message shifting (left and right), cursor appearance, and backlight.

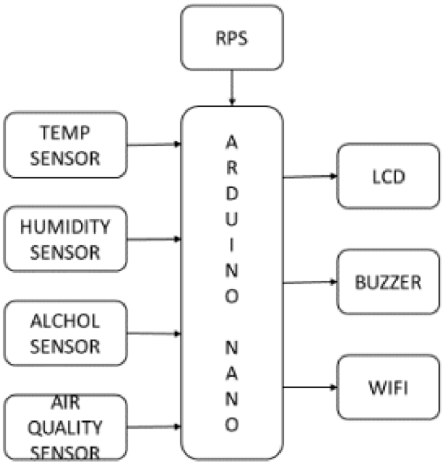
**Buzzer**

In digital systems, microcontroller pins often lack the current capacity needed to drive components like buzzers directly. A buzzer typically requires around 10 milliamps of current, while microcontroller pins provide a maximum of 1-2 milliamps. Therefore, a power transistor is used as a driver to interface between the microcontroller and the buzzer circuit, ensuring adequate current for operation.

**Wi-Fi Module**

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capabilities, produced by Espressif Systems. Initially introduced with the ESP-01 module, the ESP8266 allows microcontrollers to connect to Wi-Fi networks and make simple TCP/IP connections. Despite its initial lack of English documentation, the module's low price and minimal external components drew significant interest from the maker community. The ESP8266 has since been succeeded by the ESP32, which offers enhanced features and capabilities. The ESP8285 is a variant of the ESP8266 with 1 MiB of built-in flash, enabling single-chip Wi-Fi connectivity.

## IV.BLOCK DIAGRAM




## V.CONCLUSION

The use of WSN in this research allows no cables and electrical connections near the nodes, thus $CO_2$ could be monitored in an environment without any constraint; the use of Zigbee technology also allows the sensors to enter into sleep mode to save batteries and just collect data from time to time, since the change in $CO_2$ concentration is only observed after a certain time and therefore it is not necessary for the system to keep values all the time. By using the proposed system, it was demonstrated that the use of speed bumps to limit speed traffic around campus increase $CO_2$ emissions, since the car engines require more acceleration to pass over the bumps. Although, the variation of 60 ppm detected in this work is minimal, as the number of speed bumps increase around campus, the related air pollution also increases proportionally; therefore other solutions for reducing vehicle speeds should be implemented to reduce the $CO_2$ emissions

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