Smart City Solution for Mitigating Hygiene Issue and Alleviating Traffic Congestion

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***Abstract*—The rapid urbanization witnessed globally has led to a myriad of challenges, with hygiene problems and traffic congestion ranking among the most pressing issues. In response, this project proposes a comprehensive Smart City framework aimed at addressing these challenges through innovative technology integration and data-driven solutions. The primary objective of this project is to harness the power of digital technologies to enhance public health and transportation efficiency within urban environments. Through the deployment of smart sensors, IoT devices, and advanced data analytics, our approach aims to monitor and manage hygiene factors such as waste management, sanitation facilities, and air quality in real-time. Furthermore, to tackle the issue of traffic congestion, the project advocates for the implementation of intelligent transportation systems (ITS) that utilize real-time traffic data, predictive analytics, and smart infrastructure to optimize traffic flow, reduce congestion, and promote sustainable modes of transportation.**

Keywords
Traffic signal control systems, Data Acquisition, AI, Machine Learning, IoT, Hygiene Detection (Gas, Temperature Sensor)

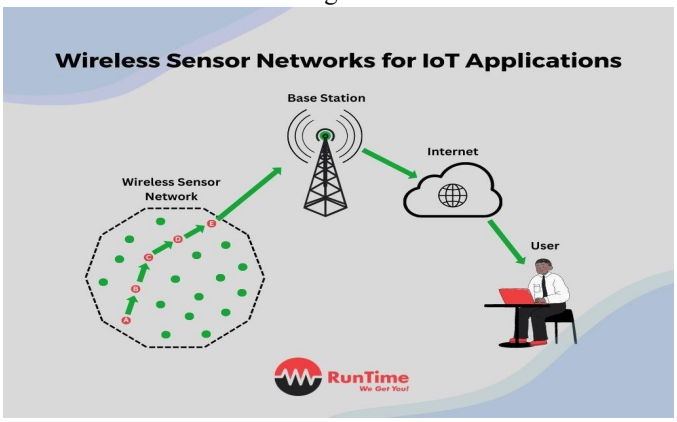
I. INTRODUCTION

Traditional traffic management systems often lack the ability to dynamically adjust signal timings based on real-time traffic conditions. This project proposes a smart traffic system that integrates AI algorithms with embedded systems to accurately count vehicles and prioritize signal timings accordingly. By leveraging advanced technologies, this system aims to optimize traffic flow and improve the overall commuting experience.

A. The Smart City solutions that comprises three main components:

Sensor Network: The deployment of IoT sensors for real-time monitoring of traffic congestion involves strategically situating sensors at key points within road networks. These sensors gather data on traffic flow, vehicle speeds, and

congestion levels. Collected data is transmitted wirelessly to central servers for analysis, enabling real-time insights into traffic conditions. Automated alerts can be generated for traffic congestion, allowing for timely interventions and adjustments to improve traffic flow and alleviate congestion.



Data Analytics: Utilization of big data analytics and machine learning algorithms to process the vast amount of data collected from sensor networks, enable predictive modeling and proactive decision-making.

Smart Infrastructure: Integration of smart traffic management systems, including adaptive traffic signals, dynamic toll pricing and smart parking solutions to optimize traffic flow and reduce congestion.

B. Hygiene Detection and Monitoring Sensors:

Gas Sensor : Industrial toxic gas and oxygen gas detectors monitor the presence of gases in a specified area and sound an alarm when they reach dangerous levels. Gas detectors are typically installed where there is a potential for a gas leak, and where unsafe gas levels pose an immediate danger to workers or equipment. So in this project we are placing the gas sensor in the traffic system where it detects and gives the amount of toxic content in that particular area.

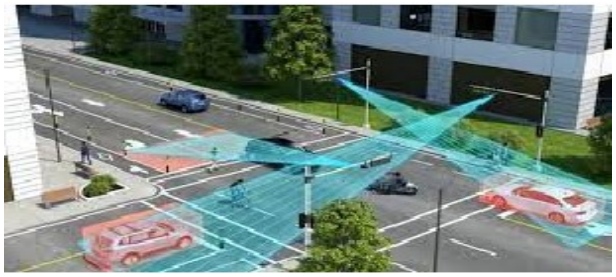
Temperature Sensor : A temperature sensor is used to measure the degree of coldness or hotness in an object or in a particular area and alerts the management if there is any discrepancy in the temperature. Similarly too much moisture in the air can also create problems. When the humidity is too high or too low, it can cause damage; therefore, it is best to choose a temperature sensor that notifies you about the amount of humidity as well as the temperature. We use a temperature sensor to measure and detect the absolute temperature, Heat index and the humidity over the region.

C. Traffic System Management:

Active infrared sensors work with radar technology and they both emit and receive infrared radiation. This radiation hits the objects nearby and bounces back to the receiver of the device. Through this technology, the sensor can not only detect movement in an environment but also how far the object is from the device.

In our project we use two IR sensors which is depicted or meant to be the maximum congestion distance that can be allowed in a traffic signal. If congestion occurs within this limit we will get an indication stating its an "Normal Traffic", but if the congestion persists for a prolonged time the indication changes stating "Heavy Traffic" which can be viewed with the help of LED and LCD displays.

The AI helps predict traffic and determine routes by collecting and analyzing large volumes of data from various sources, such as sensors, cameras, GPS, and social media, AI can help predict traffic patterns and optimize routes, schedules, and congestion management.



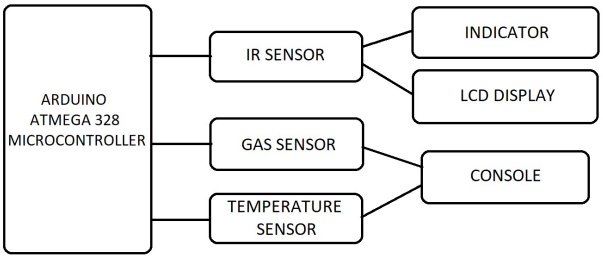
D. Existing Work:

Previous studies have explored various approaches to traffic management, including fixed-time signal control and simple vehicle detection methods. However, these methods often lack adaptability and efficiency in handling fluctuating traffic conditions. Some recent research has begun to incorporate AI techniques for traffic prediction and optimization, but there's still a gap in implementing real-time signal prioritization based on accurate vehicle counting.

E. Proposed Work:

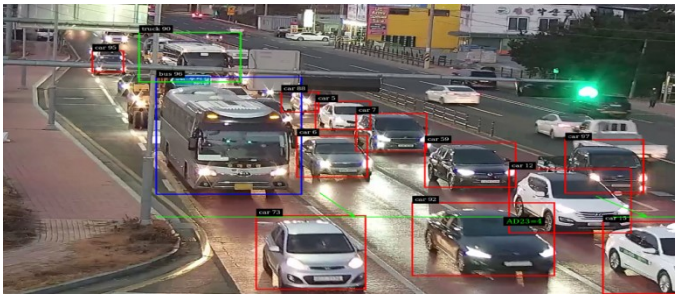
The proposed system will utilize a combination of AI algorithms, such as computer vision and machine learning, along with embedded systems for real-time data processing. The system will employ cameras or sensors at intersections to accurately count vehicles and analyze traffic patterns. Based on this data, AI models will dynamically adjust signal timings to prioritize the flow of traffic in congested areas. Additionally, the system will include mechanisms for emergency vehicle detection and priority signaling.

F. Block digram:



1) Anaconda (Python distribution) :

Anaconda is a distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. The distribution includes data-science packages suitable for Windows, Linux, and macOS. It is developed and maintained by Anaconda, Inc., which was founded by Peter Wang and Travis Oliphant in 2012. As an Anaconda, Inc. product, it is also known as Anaconda Distribution or Anaconda Individual Edition, while other products from the company are Anaconda Team Edition and Anaconda Enterprise Edition, neither of which are free.



Package versions in Anaconda are managed by the package management system conda. This package manager was spun out as a separate open-source package as it ended up being useful on its own and for things other than Python. There is also a small, bootstrap version of Anaconda called Mini conda, which includes only conda, Python, the packages they depend on, and a small number of other packages..

2) Arduino uno:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010. The microcontroller board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It has the same microcontroller as the Arduino Nano board, and the same headers as the Leonardo board. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

3) Gas sensor:

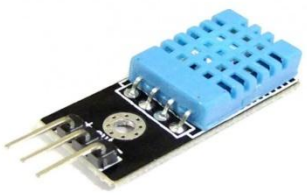
A sensitive material MQ-8 Hydrogen Gas Sensor Module H2 Alarm Detection use in clean air low conductivity tin oxide (SnO2). When there is the environment in which the combustible gas sensor, conductivity sensor with increasing concentration of combustible gases in air increases.

Using a simple circuit to convert the change in conductivity of the gas concentration corresponding to the output signal. MQ-8 hydrogen gas sensor of high sensitivity, the monitoring of the other hydrogen-containing gas is also very satisfactory.

This sensor can detect a wide range of hydrogen gas, city gas, in particular, is a low-cost sensor for a variety of applications.
Suitable for home or industrial hydrogen leakage monitoring devices. Cannot interfere with ethanol vapour, soot, carbon monoxide, and other gases.

4) Temperature sensor:

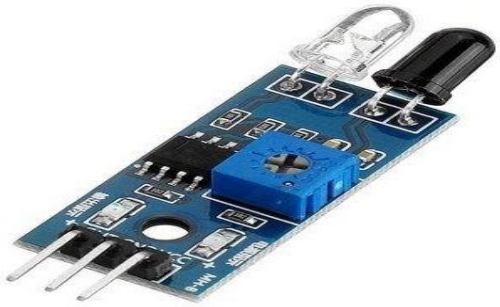
The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). Compared to the DHT22, this sensor is less precise, less accurate, and works in a smaller range of temperature/humidity, but its smaller and less expensive.



The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.
The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

5) IR Sensor:

LM393 is a dual voltage comparator integrated circuit often used in electronic circuits. When paired with an infrared sensor, it can be used to detect infrared light and convert it into a digital signal.

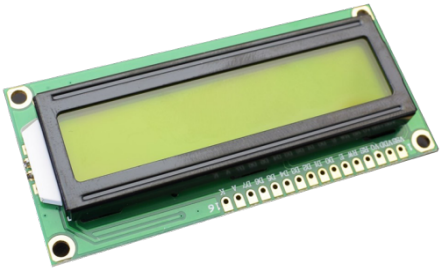


The LM393 comparator-based infrared sensor is commonly used in applications such as proximity sensing, object detection, and line following in robotics. The comparator helps in comparing the voltage levels from the infrared sensor and providing a digital output based on the comparison.
Photoelectric sensor module is a sensor module which you can use to identify the distance between obstacles, identifying changes in surroundings etc. applications. It has an IR transmitter, IR Receiver, LM393 and a potentiometer to set a threshold for digital output. When light brightness of ambient is less than the set threshold, DO-side output is high, when light brightness of ambient is over the threshold, DO-ended output is low. This module can be used in obstacle detection in autonomous robots and cars, in positional feedback for control system, industrial safety system, Wheel encoder etc.

6) LCD Display:

The LiquidCrystal library allows you to control LCD displays that are compatible with the Hitachi HD44780 driver. There are many of them out there, and you can usually tell them by the 16-pin interface.
The LCDs have a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display.

The operating voltage of this LCD is 4.7V-5.3V. It includes two rows where each row can produce 16-characters. The utilization of current is 1mA with no backlight. Every character can be built with a 5×8 pixel box the alphanumeric LCDs alphabets & numbers is display can work on two modes like 4-bit & 8-bit. These are obtainable in Blue & Green Backlight. It displays a few custom generated characters



7) LED indicator:

LED stands for light emitting diode. LED lighting products produce light up to 90% more efficiently than incandescent light bulbs.

An electrical current passes through a microchip, which illuminates the tiny light sources we call LEDs and the result is visible light.

8) Smacc usb cable:

This is a Cable For Arduino UNO/MEGA (USB A to B)-1feet, you can use it to connect “Arduino Uno”, “Arduino Mega 2560″ or any board with the USB female A port of your computer. Length is approximately 20 cm. Cable color and shape may vary slightly from image as our stock rotates.

- Fully compatible with the PC.
- Molded strain relief and PVC over molding to ensure a lifetime of error-free data transmissions.
- Aluminum under mold shield helps meet FCC requirements on KMI/RFI interference.
- Foil and braid shield complies with fully rated cable specifications reducing EMI/FRI interference.

G. Benefits and application:

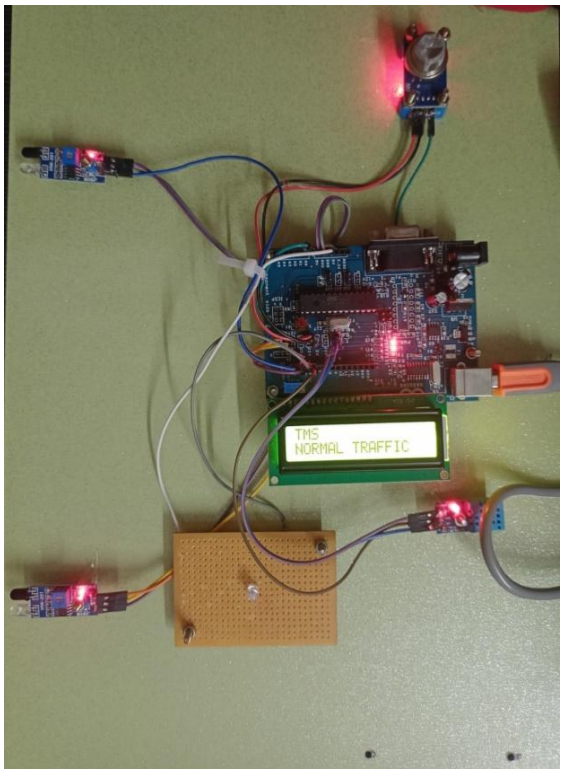
This traffic system management offers several benefits:

- Real-time Traffic Monitoring: Smart city solutions utilize sensors and data analytics to monitor traffic flow in real-time, allowing for the optimization of traffic signals and routes to reduce congestion.
- Traffic Prediction and Planning: Advanced algorithms can predict traffic patterns based on historical data and events, enabling authorities to proactively adjust transportation routes and schedules to minimize congestion.

- Dynamic Traffic Management: Smart traffic signals can adjust their timing based on current traffic conditions, optimizing the flow of vehicles and reducing idling time at intersections.
- Emergency Response Optimization: In the event of accidents or emergencies, smart city technologies can reroute traffic and guide emergency vehicles to their destinations more quickly, minimizing disruptions and improving overall traffic flow.

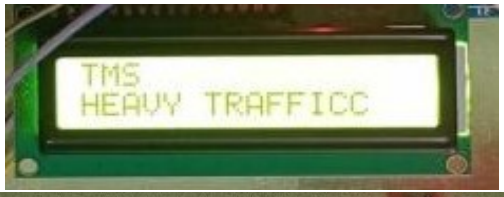
H. Results and Discussion :

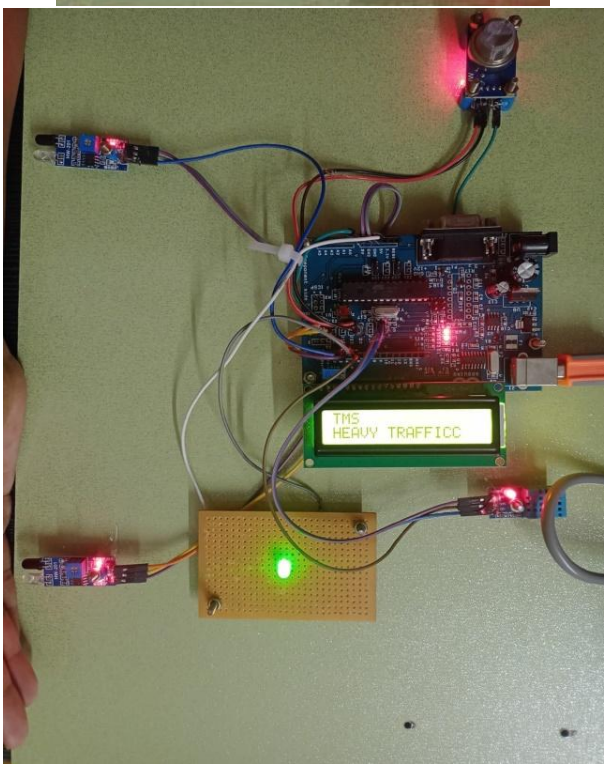
- The gas sensor is used to detect the toxic gas and pollution present in the atmosphere over the particular region.



- The temperature sensor is used to measure the heat index, temperature and humidity present in the environment.
- These two present the results of the environment conditions of the congestion zone.
- By using the AI technology such as machine learning and computer vision we can able to detect the vehicle count.
- The IR sensors are used to detect the maximum vehicle congestion that can be allowed in a traffic signal.
- If traffic occurs within the specified limit it indicates that it's a "Normal Traffic".

- If the congestion persists for a long time then it indicates as "Heavy Traffic".



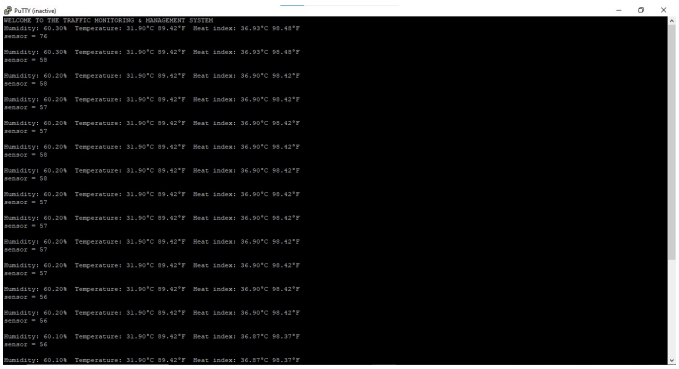


I. Putty Software :

PuTTy is a free and open-source terminal emulator, serial console and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet, rlogin and raw socket connection. It can also connect to a serial port.

PuTTY software displays the output range of humidity, temperature, heat index, and sensor values. This is very efficient for capturing variations every second. Humidity and Temperature indicate the values of humidity & temperature in the surroundings. Heat index indicates the highest temperature value observed.

Sensor indicates the measurement of toxic gas. The sensor value increases when the toxic or dangerous gas content is heavier in the region.



CONCLUSION

This project aims to develop an innovative solution for traffic management by integrating AI and embedded systems. By accurately counting vehicles and dynamically adjusting signal timings, the proposed system has the potential to significantly improve traffic flow efficiency and enhance overall road safety. Further development and testing will be conducted to validate the effectiveness and reliability of the system in real-world scenarios.

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