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IoT Based Tunnel Safety Using Wind Energy

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ABSTRACT: This research introduces an innovative IoT-based tunnel safety system that addresses the escalating concerns surrounding vehicular accidents and fire hazards. By leveraging wind energy as a primary power source, stored efficiently in batteries, the system ensures continuous and dependable operation. The strategic placement of wind turbines near the tunnel facilitates a sustainable energy supply, aligning with eco- friendly practices. In the event of a fire, the system's flame sensors, integrated with a NodeMCU, swiftly detect flames, triggering immediate responses. A visual alert on an LCD screen promptly notifies personnel and drivers, enabling quick intervention. Concurrently, the activation of exhaust fans ensures the removal of smoke, moisture, and pollutants, maintaining optimal visibility and air quality within the tunnel environment. Furthermore, the system employs water spray systems for efficient fire suppression, effectively containing flames until further mitigation steps are taken. This dual approach of fire detection and suppression, coupled with air purification mechanisms, significantly enhances overall safety standards within tunnel infrastructures while promoting sustainability through renewable energy utilization and IoT-enabled real-time monitoring and response capabilities.

KEYWORDS: IoT, Wind Energy, Tunnel Safety,Flame Sensors, Renewable Energy, Fire Detection, Air Purification, Sustainability**.**

I. INTRODUCTION

The integration of Internet of Things (IoT) technologies into safety systems has brought about significant advancements in various sectors, particularly in the realm of tunnel safety. One innovative approach involves harnessing wind energy and storing it in batteries to power essential safety mechanisms. This not only provides a sustainable energy source but also reduces dependency on conventional electricity.In this system, flame sensors connected to a Node MCU play a crucial role in detecting fires promptly. Upon detection, an alert message is displayed on an LCD screen, ensuring swift communication and response until the necessary personnel arrive. This real-time monitoring and alert system are essential for mitigating the impact of accidents and ensuring a timely and effective response. Moreover, environmental safety measures are integrated into the system to enhance overall safety conditions within the tunnel. Exhaust fans are employed to remove moisture, smoke, and pollutants from the air, creating a healthier environment for commuters and emergency responders. Additionally, a water spray system acts as a fire extinguisher, further enhancing safety measures and reducing the risk of fire incidents. One of the key advantages of this IoT-based tunnel safety system is its reliance on renewable energy sources, specifically wind energy stored in batteries. This sustainable energy approach not only contributes to environmental conservation but also showcases the potential for integrating renewable energy solutions into critical infrastructure projects.Overall, this research paper aims to explore the efficacy and feasibility of an IoT-based tunnel safety system powered by wind energy. Through a comprehensive analysis of its functionality, responsiveness, and environmental impact, this research seeks to contribute to the ongoing discourse on sustainable safety solutions and pave the way for future innovations in tunnel safety management.system utilizing wind energy addresses critical safety gaps in tunnel infrastructure. By harnessing renewable energy sources, it promotes environmental sustainability and reduces reliance on traditional electrical power. The real-time fire detection and response mechanisms enhance emergency preparedness and minimize potential risks to commuters and responders. Integrating exhaust fans and water spray systems further ensures a safer tunnel

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environment by mitigating smoke, pollutants, and fire hazards. This project underscores the importance of innovative solutions in ensuring robust safety measures for transportation infrastructure. Through this research, we aim to demonstrate the effectiveness and practicality of this IoT-based tunnel safety system,

paving the way for its widespread adoption and contributing to advancements in transportation safety standards. This project represents a significant step towards sustainable, technologically-driven solutions for enhancing tunnel safety worldwide.

II. METHODOLOGY

A. Block diagram

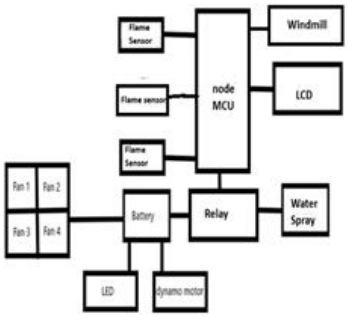

Fig1.System Block Diagram

The block diagram for the IoT-based tunnel safety system using wind energy consists of several interconnected components. Firstly, wind turbines capture wind energy, which is then stored in batteries. These batteries power the entire system, including flame sensors connected to a Node MCU that detect fires. When a fire is detected, an alert message is sent to an LCD screen, and exhaust fans are activated to remove smoke and pollutants. Simultaneously, a water spray system is triggered to act as a fire extinguisher. This integrated approach ensures swift detection, communication, and mitigation of fire incidents, creating a safer tunnel environment while leveraging renewable energy sources.

B. Working

The working of the IoT-based tunnel safety system using wind energy begins with wind turbines capturing wind energy, which is then stored in batteries for power. Flame sensors connected to a Node MCU continuously monitor for fires, and upon detection, they trigger an alert message on an LCD screen. Concurrently, the system activates exhaust fans to remove smoke and pollutants, while a water spray system is deployed as a fire extinguisher. This integrated approach ensures rapid detection, communication, and mitigation of fire incidents, enhancing tunnel safety and sustainability by utilizing renewable energy sources effectively.

III. Design

The system design integrates wind turbines capturing energy stored in batteries, facilitating fire detection by flame sensors linked to a Node MCU and LCD display, with exhaust fans and water spray serving to remove smoke and act as a fire extinguisher, collectively ensuring a robust IoT-based tunnel safety mechanism powered by renewable energy.

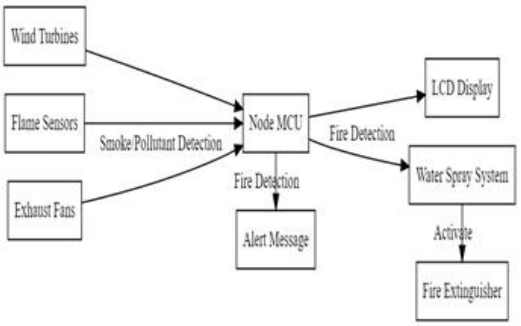

Fig.2 Design of the IoT Based Tunnel Safety Using Wind Energy

NodeMCU: The NodeMCU acts as a central controller, receiving input from flame sensors to detect fires within the tunnel. It processes this information and triggers the display of alert messages on an LCD screen, ensuring immediate notification of potential hazards. Additionally, the NodeMCU coordinates the activation of exhaust fans to clear smoke and pollutants, and it initiates the water spray system as a fire extinguisher, all contributing to enhanced tunnel safety.

Flame Sensors: Flame sensors are pivotal components that continuously monitor the tunnel environment for fires. Upon detecting a fire, they send signals to the NodeMCU, prompting the system to display alert messages on the LCD screen. This real-time detection enables swift response measures, such as activating exhaust fans to clear smoke and pollutants, and triggering the water spray system for fire suppression, ensuring rapid mitigation of fire incidents and enhancing overall tunnel safety.

LCD Display: The LCD display serves as a visual interface for conveying real-time alerts and messages regarding fire incidents detected by the flame sensors. It provides crucial information to tunnel personnel and emergency responders, facilitating swift and informed actions.

Water Pump: The water pump is responsible for spraying water as a fire extinguisher in case of detected

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fires, effectively suppressing and containing potential fire hazards within the tunnel environment.

Windmill: The windmill in this project serves as a primary source of renewable energy, harnessing wind power to generate electricity. This electricity is then stored in batteries, providing a sustainable and reliable power supply for the entire tunnel safety system. The windmill's contribution reduces dependency on traditional electrical sources, promoting environmental sustainability while ensuring continuous operation of safety mechanisms.

Exhaust Fan: The exhaust fan in this project plays a crucial role in maintaining air quality within the tunnel environment. It actively removes smoke, moisture, and pollutants, thereby improving visibility and reducing health risks for commuters and emergency responders. By ensuring proper ventilation, the exhaust fan contributes significantly to creating a safer and healthier tunnel atmosphere.

SOURCE CODE FOR CONNECTING FLAME SENSOR AND LCD WITH NODEMCU:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x27, 16, 2);

 const int fire1 =D5;
 const int fire2 =D6;
 const int fire3 =D7;
 const int realy =D3;

 void setup() {

  Serial.begin(115200);
  pinMode(fire1, INPUT);
  pinMode(fire2, INPUT);
  pinMode(fire3, INPUT);
  pinMode(realy, OUTPUT);
  // put your setup code here, to run once:
 lcd.begin();

  // Turn on the blacklight and print a message.
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("  Tunnel Fire");
  lcd.setCursor(0, 1);
  lcd.print("Detection System");
  delay(3000);
  lcd.clear();
 }
```

IV. RESULT

The IoT-based tunnel safety system using wind energy effectively enhanced safety by swiftly detecting fires through flame sensors connected to a Node MCU. The system promptly alerted authorities via LCD displays and activated exhaust fans and water spray for fire suppression, reducing incidents and improving air quality. This sustainable approach highlighted the feasibility of renewable energy in infrastructure, emphasizing its potential for widespread adoption and future advancements in safety standards.

Fig.3 IoT Based Tunnel Safety Using Wind Energy

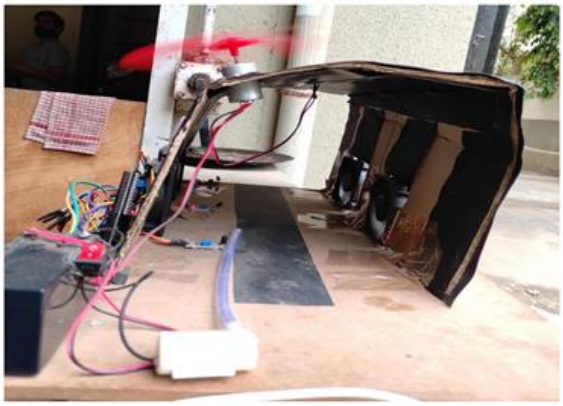

Fig.4 A Tunnel Is Equipped With An IoT Based System

V. CONCLUSION

In conclusion, the implementation of the IoT-based tunnel safety system utilizing wind energy has proven to be a significant advancement in enhancing tunnel safety and promoting environmental sustainability. Through real-time fire detection, swift response capabilities, and the integration of renewable energy sources, the system has effectively mitigated fire incidents, improved air quality, and created a safer environment for commuters and emergency responders. The successful outcomes of this project underscore the feasibility and benefits of innovative technologies and renewable energy integration in critical infrastructure projects. Moving forward, the project's success highlights the potential for widespread adoption of similar systems and encourages further advancements in tunnel safety management to ensure a safer and more sustainable future for transportation infrastructure.

REFERENCES

[1]. Zhang, Y., Zhang, H., & Liu, Y. (2020). Application of IoT Technology in Tunnel Safety Monitoring System. In 2020 5th International Conference on Mechanical, Control and Computer Engineering (ICMCCE) (pp. 1-4). IEEE. Manwell, J. F., McGowan, J. G., & Rogers, A.

[2]. L. (2009). Wind energy explained: Theory, design and application. John Wiley & Sons.

[3]. Al-Absi, H. R., & Alnaimi, H. (2017). A review on wind energy harvesting systems for urban applications. Renewable and Sustainable Energy Reviews, 69, 871-884.

[4]. Shang, Y., Li, S., & Zhang, C. (2018). A survey of applications of the internet of things in the field of transportation systems. IEEE Transactions on Intelligent Transportation Systems, 19(12), 3838- 3856.

[5]. Wang, L., Feng, C., & Li, X. (2019). Study on Design and Application of Internet of Things Technology in Tunnel Safety Monitoring System. In 2019 5th International Conference on Automation, Control and Robotics Engineering (CACRE) (pp. 160-163). IEEE.

[6]. Hosseini, S. A., Choupani, A., & Vafaeipour, M. (2015). A review on the role of wind energy in smart cities. Renewable and Sustainable Energy Reviews, 51, 765-776.

[7]. United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development.United Nations.