Smart Tunnel for Maintenance and Security

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***Abstract*—Abstract This paper presents an IoT based smart tunnel result for bettered conservation and security. The system uses LED lighting, air quality monitoring, and video surveillance to give real- time data and perception to authority. The system is controlled using Blynk, a popular IoT platform, and can be entered from anywhere in the world. The system uses a variety of sensors to collect data, including BH1750 light sensor to measure light situations MQ135 air quality sensor to measure air quality ESP32 cam for video surveillance. The data collected by the sensors is transferred to the ESP32 module, which processes it and sends it to the Blynk dashboard. The system also includes an addict, which is controlled by the ESP32 module. The system has a number of benefits, including bettered conservation The system provides real- time data on the condition of the tunnel, which can help using authority to identify and address implicit problems beforehand on. Advanced security The system's video surveillance capabilities can help using authority to respond to security incidents in real time. Reduced costs The system can help to reduce conservation costs by relating and addressing implicit problems beforehand on. Overall, the proposed IoT predicated smart driver result is a comprehensive and effective way.**

***Index Terms*—IoT, Smart tunnel, Maintenance, Security, Air quality monitoring, Video surveillance, Blynk, Fan control, Cloud server, Real-time monitoring, Remote control**

I. Introduction

Tunnel are critical structure for transportation systems around the world. still, they can be challenging to maintain and secure. This is due to a number of factors, including their length, complexity, and constantly remote position. In recent times, there has been a growing interest in using IoT technologies to conservative and security of coverts. IoT- predicated smart layer results can give real- time data and perceptivity to management implicit problems beforehand on. They can also help security system by furnishing video surveillance and other security features. This paper presents an IoT- predicated smart tunnel affect that uses LED lighting, air quality monitoring, and video surveillance to meliorate conservation and security. The system is controlled using Blynk, a popular IoT platform, and can be entered from anywhere in the world. The system uses a variety of sensors to collect data, including BH1750 light sensor to measure light situations MQ135 air quality sensor to measure air quality ESP32 cam for video surveillance. The system also includes a addict, which is controlled by the ESP32 module. The addict is used to measure air quality in the tunnel if it becomes poor. The system has a number of benefits, including bettered conservation The system provides real- time data on the condition of the tunnel.

- To lessen the life risks of driver.
- To detect light and air quality.

II. Related Works

Our work has maintain an integrity among more than 3 projects.In their projects the developers has done wonderful work but consisting only one specified feature.Our team has brought their works together and made those specified projects a multi-functional featured. The works and papers that helped us making this variation. Pravalika Prasad [1] in their project they build a home automation system and controlle light fan remotely using esp32 module. Abhimanyu Jadli, Apratim Sadhu proposed a surveillance system [2] where thy have used esp32 cam module.

Kodali, Ravi Kishore with them [3] in their project,they create IOT based industrial plant safety gas leakage detection system, which detect harmful gasses.

Cihan, Ayşe Nur [4] they build an indoor smart lamp using light sensor , which turn on the light when the room is dark.

Cao, Jianfeng [5] has done work for Internet of things based on wireless sensor in tunnel construction monitoring

Megantoro, Prisma [6] their project has worked for air quality measurement using ESP32 for environmental aerial condition study

III. Methodology

The proposed IoT- predicated smart tunnel result consists of the following factors Sensors BH1750 light sensor, MQ135 air quality sensor, ESP32 cam ESP32 microcontroller Motorcar Blynk app Blynk dashboard The system is designed to be modular and scalable, so that fresh factors can be easily added as demanded. The system works as follows The sensors collect data on the condition of the tunnel, including light situations, air quality, and video footage. The ESP32 microcontroller processes the data from the sensors and sends it to the Blynk app. The proposed IoT predicated smart tunnel result can be executed using the ensuing way Emplace the sensors at various locales in the tunnel. Connect the sensors to the ESP32 microcontroller.Configure the ESP32 microcontroller to connect to the Blynk app. produce a Blynk dashboard to display the data from the sensors and to control the addict. Emplace the system and test its functionality.

A. Circuit Diagram and Components:

- **ESP 32**: The widely used ESP32 is a very adaptable microcontroller and system-on-chip (SoC) in the embedded systems and Internet of Things (IoT) space. It was created by Espressif Systems as an enhanced version of the ESP8266. With its dual-core Tensilica LX6 processor, it offers improved processing performance and multitasking, built-in Wi-Fi and Bluetooth, extensive peripheral support for connecting to sensors and other devices, secure boot, and flash encryption for firmware and data security. It supports both traditional Bluetooth and Bluetooth Low Energy, and its ultra-low power modes make it perfect for battery-operated applications. The ESP32 is a great option for a variety of IoT applications because of its 12-bit ADC for analog data capture, vast programming tools, affordability, and robust community support.
- **BH1750 SENSOR**: BH1750 16-bit Ambient Light sensor from Rohm. Given that people and many other living things depend on the ability to monitor light levels, it's a popular place to start when learning about microcontrollers and sensors. With its extraordinarily low current consumption, this sensor can be easily interfaced with microcontrollers via the I2C communication standard. With light exposure, a photodiode with a PN junction—which produces electron-hole pairs in the depletion region—is used to power the device. This is converted into electricity via the internal photoelectric effect, with the amount being directly correlated with the intensity of the light. Then, an operational amplifier (Opamp), a flexible and essential part for light level monitoring and control in a variety of applications, transforms this electrical current into a matching voltage.
- L298N MOTOR DRIVER: A motor driver showcases itself as an interface between the motor and the micro controller. The reason is that the micro controller and the motor work on different ranges of voltages. The engine will use up a higher current level than the micro controller. We require a motor driver module when connecting two devices that operate under different current levels to a power supply voltage. In this case, a motor acts as a third device that steps up or steps down the voltage supply. The majority of motor drivers in the market now are in the form of ICs. There are different driver motors; hence they have other characteristics. We then connect these motor driver ICs to the motor controller through an H bridge circuit. It accepts standard TTL logic levels (Control Logic) and controls inductive loads such as relays, solenoids, DC and Stepper motors. This is a 15 pin IC. According to the L298 datasheet, its operating voltage is +5 to +46V, and the maximum current allowed to draw through each output 3A. This IC has two enable inputs, these are provided to enable or disable the device independently of the input signals.
- **MQ-135 Gas sensors**: The MQ-135 Gas sensors are used in air quality control equipments and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. The MQ-135 sensor module comes with a Digital Pin which makes this sensor to operate even without a https://components101.com/microcontrollersmicrocontroller and that comes in handy when you are only trying to detect one particular gas
- ESP32 CAM: The ESP32 Based Camera Module developed by AI-Thinker. The controller is based on a 32-bit CPU has a combined Wi-Fi + Bluetooth/BLE Chip. It has a built-in 520 KB SRAM with an external 4M PSRAM. Its GPIO Pins have support like UART, SPI, I2C, PWM, ADC, and DAC. The module combines with the OV2640 Camera Module which has the highest Camera Resolution up to 1600 × 1200. The camera connects to the ESP32 CAM Board using a 24 pins gold plated connector. The board supports an SD Card of up to 4GB. The SD Card stores capture images. It's worth noting that the ESP32-CAM is a versatile development board with camera capabilities, but the performance and capabilities of image processing and computer vision tasks may be limited compared to dedicated vision systems or more powerful hardware platforms. However, it offers a cost-effective and compact solution for many projects that require basic camera functionality and wireless connectivity.The ESP32-CAM is suitable for various applications, including video surveillance, home automation, robotics, smart agriculture, and remote monitoring.

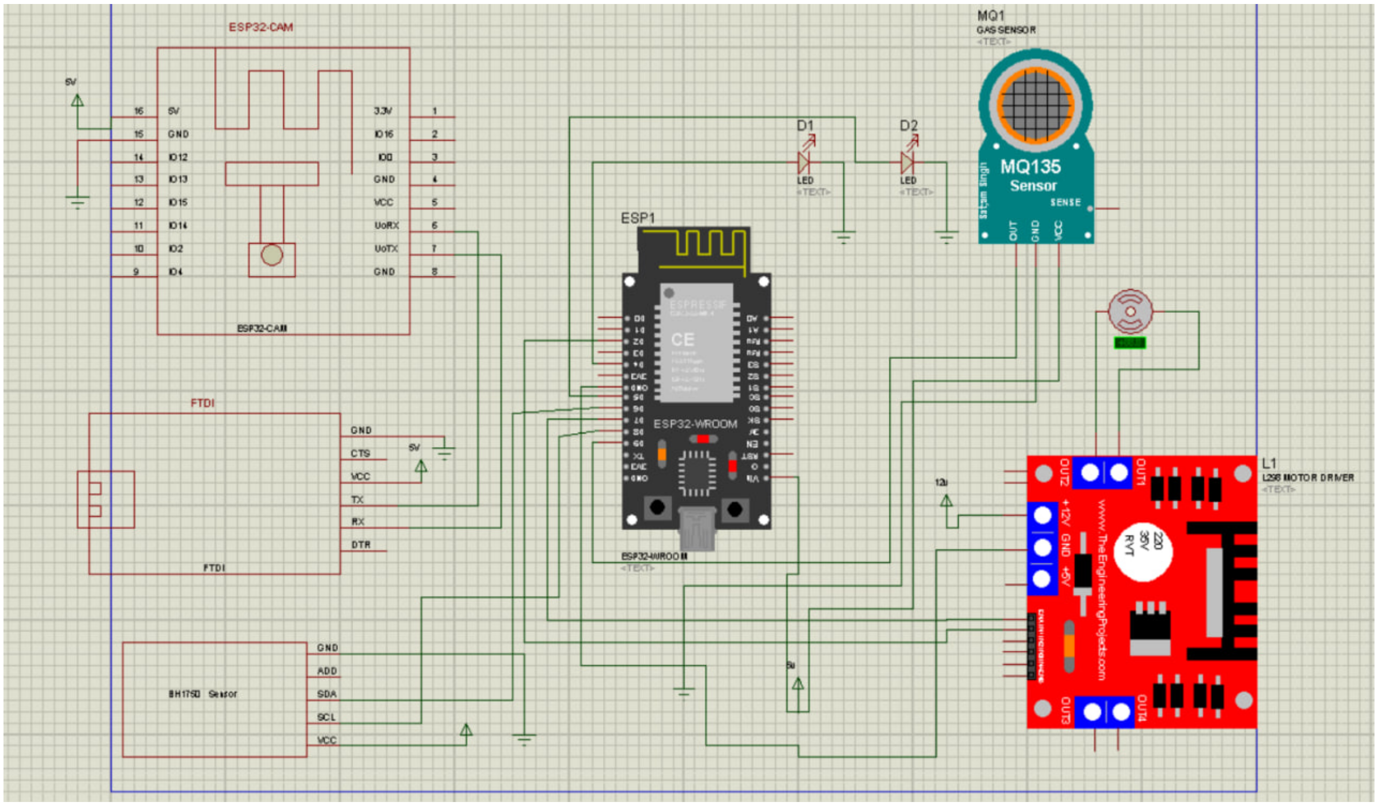

Fig. 1. Circuit connection of our project

- BRUSSLESS FAN: DC Brushless Fans (BLDC) Products in the DC **fan** family are electromechanical products used to induce air movement and operate from a DC power source

IV. RESULT

TABLE I
PERFORMANCE METRICS

SENSOR	**Accuracy (%)**
BH1750 LIGHT SENSOR	+- 2%
MQ135 AIR QUALITY	+- 10%

V. FUTURE WORK

Extend the system to include fresh features, analogous as A business monitoring system to descry business and other business incidents A power operation system to optimize the use of energy A predictive conservation system to identify and address implicit problems before they beget failure. apply machine knowledge ways to increase the delicacy and responsibility of the system. Develop alliances with tunnel authority and other stakeholders to fix the system in real- world surroundings.

VI. DISCUSSION

The proposed IoT- predicated smart tunnel result has the implicit to significantly control the conservation and security

Fig. 2. Picture of our robot

of coverts. The system can give real- time data and perceptivity to tunnel authority. One of the pivotal benefits of the proposed system is its modularity and scalability. This makes it easy to add fresh features to the system as demanded. For illustration, a business monitoring system or a power operation system could be easily added to the system in the future. Another pivotal benefit of the proposed system is its affordability. The system can be executed using fairly affordable factors, analogous as the ESP32 microcontroller and the Blynk platform. This makes it a doable option for tunnel authority of all sizes. still, there are also some challenges that need to be addressed before the proposed system can be considerably posted. One challenge is the need to develop accurate and reliable sensors. The sensors used in the system need to be suitable to directly measure light situations, air quality, and other environmental conditions in the tunnel. Another challenge is the need to develop robust and secure software. The software used to control the system needs to be reliable and secure. Despite these challenges, the proposed IoT- predicated smart tunnel result has the implicit to revise the way that coverts are maintained and secured. The system has the implicit to make coverts safer, more effective, and farther cost-effective to operate. Broader implications The proposed IoT- predicated smart tunnel result has the implicit to be applied to other structure systems, analogous as islets, roads, and power grids. By using IoT technologies to collect data and cover the condition of structure, we can identify and address implicit problems beforehand on, before they beget failures. For illustration, by using business monitoring data to optimize business flux, we can reduce business and emigrations. We can also use the data to make better design and operation of transportation networks.

VII. Conclusion

In conclusion, the proposed IoT- predicated smart tunnel result is a comprehensive and effective way to meliorate the conservation and security of coverts. The system uses LED lighting, air quality monitoring, and video surveillance to give real- time data and perceptivity to tunnel authority. The system is controlled using Blynk, a popular IoT platform, and can be entered from anywhere in the world. The system has a number of benefits, including bettered conservation The system provides real- time data on the condition of the tunnel, which can help tunnel authority to identify and address implicit problems beforehand on. Advanced security The system's video surveillance capabilities can help tunnel authority to descry and respond to security incidents in real time. Reduced costs The system can help to reduce conservation costs by relating and addressing implicit problems beforehand on. It can also help to reduce energy costs by using LED lighting and suckers only when necessary. Modularity and scalability The system is designed to be modular and scalable, so that fresh factors can be easily added as demanded. Affordability The system can be executed using fairly affordable factors, analogous as the ESP32 microcontroller and the Blynk platform. The proposed system has the implicit to be considerably posted in coverts around the world. It can help to make coverts safer, more effective, and farther cost-effective to operate. By using IoT technologies to collect data and cover the condition of structure, we can identify and address implicit problems beforehand on, before they beget failures. This can help to increase the safety and responsibility of our structure, while also reducing conservation costs. The proposed system also has the implicit to be used to increase the effectiveness and sustainability of our transportation systems.

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