TRAFFIC LIGHT RECOGNITION GLASSES FOR COLOUR BLIND PEOPLE

A Mini Project Report

Submitted to the APJ Abdul Kalam Technological University

in partial fulfillment of requirements for the award of degree

Bachelor of Technology

in

Instrumentation and Control Engineering

by

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CERTIFICATE

This is to certify that the report entitled **TRAFFIC LIGHT RECOGNITION GLASSES FOR COLOUR BLIND PEOPLE** submitted by **ANEESH T** (NSS22IC014), **PRANITH R** (NSS22IC048), **S AMRUDHESH** (NSS22IC051) & **SNEHA S** (NSS22IC057) to the APJ Abdul Kalam Technological University in partial fulfillment of the B.Tech. degree in Instrumentation and Control Engineering is a bonafide record of the mini project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

We hereby declare that the mini project report **TRAFFIC LIGHT RECOGNITION GLASSES FOR COLOUR BLIND PEOPLE** , submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of Prof. LEKSHMIPRIYA J

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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Abstract

Traffic signals are an integral component of keeping the roads safe through the management of drivers as well as pedestrians. Nevertheless, those with color blindness, specifically those with red-green color vision deficiency, are frequently unable to distinguish between colors at traffic lights. This inefficiency can bring about hesitation, delay in reactions, and risks of accidents while turning at road junctions. Our solution, therefore, involves developing a working and effective project in the form of Traffic Light Recognition System for Colorblind People with Voice Assistance.

The system runs in two primary stages: Color Detection and Voice Assistance Integration. An RGB sensor (TCS34725) is employed to precisely detect the color of a traffic light, identifying red, yellow, and green. Upon detection, a DFPlayer Mini MP3 module, combined with a speaker, offers voice feedback to notify users of the signal color. This enables color-blind individuals to easily interpret traffic signals and make safer decisions on the road.

The project is intended to be low-cost, transportable, and accessible to use, dispelling the need for intricate mobile software or high-tech eyewear. The system provides instant, dependable guidance, guaranteeing availability to users in day-to-day scenarios. Further advancements in the future can include AI-powered identification, wireless access, and multiple languages support, enhancing its efficacy and convenience even more.

By providing an independent and inclusive navigation aid, this project improves road safety and gives colorblind people a straightforward yet effective assistive tool.

PROJECT TEAM

Acknowledgement

We would like to place on record our sincere gratitude to our project guide Prof. LEKSHMIPRIYA J, Assistant Professor, Instrumentation and Control Engineering, N.S.S. College of Engineering for the guidance and mentorship throughout this work.
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Contents

List of Figures

Chapter 1

Introduction

Traffic lights play a critical role in regulating road traffic and ensuring safety for both drivers and pedestrians. However, for individuals with color blindness, particularly those with red-green color vision deficiency, distinguishing between traffic signals can be challenging. This limitation can lead to delayed reactions, confusion at intersections, and increased accident risks, highlighting the need for an accessible and reliable solution.

Our project, Traffic Light Recognition System for Colorblind People with Voice Assistance, aims to bridge this gap by providing real-time auditory feedback to help colorblind individuals interpret traffic signals accurately. Instead of relying solely on visual cues, our system uses an RGB color sensor to detect the color of traffic lights and translates this information into voice guidance, ensuring that users receive clear and immediate instructions.

The project is structured into two key phases:

1) Color Detection – Implementing an RGB sensor (TCS34725) to precisely identify and differentiate red, yellow, and green lights.

2) Voice Assistance Integration – Using a DFPlayer Mini MP3 module and a speaker to provide real-time audio feedback, allowing users to make safe and informed decisions.

Designed to be compact, cost-effective, and user-friendly, this system enhances independent mobility and road safety for individuals with color blindness. Future enhancements, such as AI-based recognition, wireless connectivity, and mobile application integration, could further improve accuracy and accessibility, making traffic navigation safer and more inclusive for all road users

1.1 Objective

- To develop a portable device for colorblind individuals that detects traffic light colors (red, green, yellow) using an RGB sensor and provides real-time voice alerts through a voice module.

The main goal of this project is to create a simple and reliable traffic light recognition system for people with color blindness. Traffic signals are a crucial part of road safety, but they rely heavily on color differentiation, making it difficult for colorblind individuals to interpret them correctly. Our system aims to bridge this gap by using an RGB sensor to detect traffic light colors in real-time and providing voice-based feedback to inform the user of the signal status. This ensures that colorblind individuals can confidently recognize traffic signals without confusion, making roads safer for everyone.

Beyond just detecting colors, our focus is on making the system affordable, practical, and easy to use. Instead of complex or expensive solutions, we are designing a lightweight and portable device that can be integrated into wearables like smart glasses. The project prioritizes accuracy and efficiency, ensuring quick and reliable detection in various real-world conditions. By creating a system that is both accessible and user-friendly, we hope to make a meaningful difference in everyday life for people with color vision deficiencies.

1.2 Purpose

The purpose of this project is to enhance accessibility and independence for individuals with color blindness, especially in traffic environments where quick decisions matter. Not being able to distinguish traffic light colors can lead to hesitation, confusion, or even dangerous situations, particularly for pedestrians and drivers. Our solution provides instant voice feedback, allowing users to recognize traffic signals without second-guessing or relying on others for assistance.

More than just a tool for navigation, this project is a step towards inclusivity in transportation. Many assistive technologies are either expensive or impractical for daily use, but our focus is on creating a solution that is both affordable and effective. By using compact hardware and smart integration, we aim to develop a real-world solution that can help individuals with color blindness navigate roads with confidence. Ultimately, our goal is to make traffic environments safer and more inclusive, ensuring that everyone, regardless of their vision limitations, can travel independently and securely.

Chapter 2

Literature Review

2.1 PAPER 1

Traffic Light Recognition Assistance for Colour Vision Deficiency Using Deep Learning

Tun Yong Lee et al. presented a deep learning-based system to support people with color vision deficiency (CVD) in identifying traffic light signals in real-time. Six object detection models from the TensorFlow Model Zoo were used in the research, namely training these models on the LISA Traffic Light Dataset. The models were tested for their ability to detect and classify the colors of traffic lights during varying illumination conditions. The top-performing model, Faster RNN RESNET101 VI FPN 1024 x 1024, registered a recall of 53.41 percentage for images taken during the day and 45.41 percentage for images taken at night. The system was meant to handle real-time images from a camera stream, perform pre-processing methods to enhance color contrast, and utilize machine learning algorithms to identify traffic light colors. The research focused on enhancing recognition accuracy under different environmental conditions, especially in low-light conditions. The main findings are that although deep learning models can provide accurate traffic light detection for colorblind individuals, nighttime recognition is an area that can be improved.

This study helps us with our project through its insights into real-time color classification based on machine learning. By applying a similar strategy, we can upgrade our traffic light recognition system to achieve greater accuracy in detecting red, yellow, and green signals. Moreover, the emphasis of the study on enhancing low-light performance can help us develop our detection algorithms to perform well under various lighting conditions.

2.2 PAPER 2

Towards Context-aware Support for Color Vision Deficiency: An Approach Integrating LLM and AR

Shogo Morita et al. discussed an innovative method involving the integration of augmented reality (AR) with large language models (LLMs) to enable smart, real-time support for color vision deficiency individuals. The research created an AR-based system that captured actual-world visuals, processed them via an AI-facilitated reasoning system, and offered contextualized support to users to facilitate color identification better. The approach entailed combining a multi-modal large language model with augmented reality technology to enable real-time color identification and adaptive assistance according to the user's surroundings. The system was evaluated under different real-world settings, showing its capacity to adapt dynamically to varying lighting conditions and object appearances. The main findings indicate that AR-augmented solutions, coupled with AI-driven decision-making, greatly enhance the usability and performance of assistive color recognition systems.

This study can motivate the creation of an AR-based visualization function in our smart glasses, which will make traffic light recognition more interactive and responsive to actual environmental conditions. Using an AR-based interface can increase user interaction, offering a more natural means of differentiating traffic light signals. The study's focus on AI-based contextual support can also improve our voice-assist module, making it provide accurate and appropriate feedback based on real-time environmental conditions.

2.3 PAPER 3

A Color Guide for Color Blind People Using Image Processing and OpenCV

P K Kompalli et al. suggested an image-processing technique with OpenCV to help people suffering from color vision deficiency improve color contrast and visibility. A camera module was used in the research to obtain real-time images, which were then processed by applying color detection filters to detect and emphasize colors easily confused by colorblind persons. Edge detection, contrast enhancement, and personalized color overlays were added to the processed images to allow users to better differentiate key colors. The system also provided a grayscale mode that desaturated all other colors but the essential ones, aiding users in visually isolating important color-coded features. The major findings indicate that real-time image processing methods have the potential to enhance the perception of ambiguous colors, rendering visual information more readable for colorblind users.

Based on this research, we are able to utilize OpenCV-based color filtering and contrast adjustment procedures in our application to enhance the color recognition as well as adapt the visibility of traffic light indications to various types of lighting situations. These techniques of image processing will enable increased accuracy in terms of color identification so that end-users can easily obtain clear, recognizable visual hints while detecting traffic light indications.

2.4 PAPER 4

A Google Glass Based Real-Time Scene Analysis for the Visually Impaired

Hafeez Ali A et al. explored the implementation of a Google Glass system designed to aid the blind and visually impaired with real-time recognition of scenes. The approach they took was to employ the built-in camera on Google Glass to take pictures of what the user sees, and process them using Microsoft's Azure Cognitive Services' Custom Vision API. To improve the performance of the system in Indian scenarios, they developed a 5,000 newly annotated images dataset, retraining the Vision API to enhance its mean Average Precision (mAP) value from 63 percentage to 84 percentage with an Intersection over Union (loU) value of more than 0.5. The processed data was translated into speech and presented to the user through the bone conduction speaker in Google Glass. User assessments performed with students and faculty from the Roman and Catherine Lobo School for the Visually Impaired in Mangalore, India, revealed that the application successfully facilitated users to identify their surroundings in real time, with a total response time of less than one Second.

We are taking the idea of combining wearable technology with real-time environmental monitoring from this research to help those with sensory impairments. In particular, the method of sensing environmental information through wearable devices and processing this information to offer instant, user-centric feedback is what we are trying to accomplish in our project to create traffic light recognition glasses for colorblind people. Applying the same logic-using sensors to identify traffic light colors and providing auditory signals-we hope to augment the independence and safety of colorblind pedestrians and motorists.

2.5 PAPER 5

Wearable Travel Aids for Blind and Partially Sighted People: A Review with a Focus on Design Issues

Marion Hersh et al. present the evolution and implementation of assistive technologies for the visually impaired. Their research uses a blend of sensor-based technology, image processing software, and machine learning to improve object recognition and usability for the visually impaired. The process is done by taking real-time images through specialized sensors, processing the images using sophisticated computational models, and giving auditory or tactile feedback to the user. Their main conclusions emphasize the efficiency of sensor fusion methods in enhancing object detection accuracy and the significance of user-centered design in assistive technology. The research concludes that combining machine learning with real-time image processing greatly enhances the usability and effectiveness of assistive technology for visually impaired users.

We integrate the idea of real-time image processing and sensor integration into our project for traffic light recognition glasses for colorblind people from this paper. The methodology presented in the paper gives a platform to apply sophisticated image recognition algorithms to identify traffic light colors correctly. We also take their user-centered approach to make sure our glasses give intuitive and effective feedback to the colorblind user. The study's focus on machine learning algorithms drives our choice of using AI-based color recognition systems to improve the accuracy and reliability of traffic light detection, thereby enhancing road safety for colorblind drivers and pedestrians.

Chapter 3

Methodology

Designing the Traffic Light Recognition Glasses for Colorblind People is carried out in a systematic manner for effective design, implementation, and assessment. Since this project is for demonstration only, it doesn't recognize actual traffic lights but detects traffic light colors placed adjacent to the sensor to mimic the actual traffic light scenario.

3.1 Block Diagram

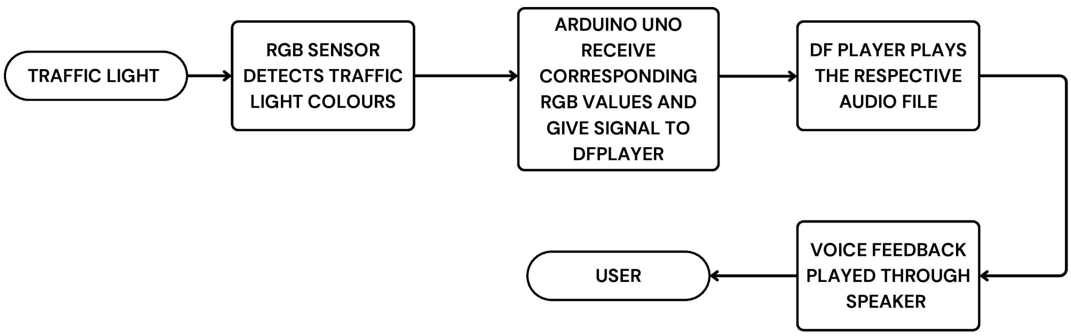


Figure 3.1: Block Diagram

1. RGB Sensor Detects Traffic Light Color An RGB sensor embedded in the smart glasses detects the color of the traffic light by analyzing its red, green, and blue components. It identifies which signal is active.

2. Arduino Uno Receives Corresponding RGB Values and Provides Signal to DFPlayer Mini.

The Arduino Uno analyzes the RGB sensor readings to know the present traffic light color. It then transmits a signal to the DFPlayer Mini to play a recorded voice message as per the sensed color.

3. DFPlayer Mini Plays the Respective Audio File After receiving the signal, the DFPlayer Mini plays the respective audio file from the SD card over the in-built speaker.

For Red Light: The speaker speaks ”Red Light”

For Yellow Light: The speaker plays ”Yellow Light”

For Green Light: The speaker plays ”Green Light”

4. Voice Feedback Played Through Speaker

The voice feedback is provided through the speaker built into the case to be carried in pocket. This gives the user real-time feedback regarding the traffic light condition.

5. User Response

The color-blind user hears the voice feedback and responds accordingly:

If the speaker plays ”Yellow Light” they slow down and get ready to stop.

If the speaker plays ”Red Light” they stop.

If the speaker plays ”Green Light” they go safely.

This system improves road safety by offering real-time auditory guidance, allowing color-blind people to drive through traffic lights confidently and independently.

3.2 Components Used

1. ARDUINO UNO
2. TCS34725 RGB SENSOR
3. DF MP3 PLAYER
4. SPEAKER
5. BREADBOARD
6. SD CARD
7. SPECTACLES
8. JUMBER WIRES

3.3 Component Overview:Understanding the Essential Elements

3.3.1 Arduino UNO

The Arduino Uno plays an essential role in processing data from the sensors . Once the system determines whether the light is red, yellow, or green, it sends this information to the voice module, which then converts the color data into spoken instructions. For instance, when a red light is detected, the voice module will announce, ”Red light,” when yellow is identified, it will say, ”Yellow light,” and for green, it will announce, ”Green light.”

Figure 3.2: Arduino UNO

3.3.2 TCS34725 RGB Sensor

The TCS34725 RGB color sensor which identifies red, yellow, and green colors by analyzing light wavelengths. An integrated IR filter helps minimize interference from sunlight, improving detection reliability. The sensor connects through an I2C interface, making it compatible with microcontrollers like Arduino and Raspberry Pi.

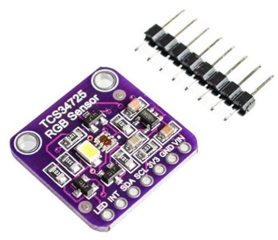


Figure 3.3: TCS34725

3.3.3 DF MP3 Player

The DFPlayer Mini MP3 Module is a compact audio playback module capable of playing MP3 files stored in a microSD card. It communicates with a microcontroller using UART (serial communication) and has basic commands for playing, pausing, and volume control. The module is used to give voice output by playing pre-recorded voice files announcing the recognized traffic light colors, like ”Red Light,” ”Green Light,” and ”Yellow Light.”

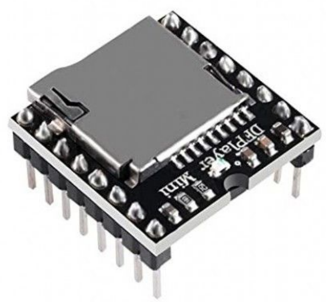


Figure 3.4: DF MP3 Player

3.3.4 Speaker

The Speaker is a device that translates electrical signals into sound. It is used to connect with the DFPlayer Mini to give clear and audible voice feedback to the user. The speaker is used to ensure that the announcements are audible to the user in different environments, thus making the system efficient in helping colorblind people identify traffic lights.

Figure 3.5: 8ohm 3W Speaker

Chapter 4

Design and Development

4.1 Working

Traffic Light Recognition Glasses uses an RGB color sensor to identify the color of traffic lights. As the user approaches a traffic light, the sensor identifies the color of the light and transfers the data to arduino UNO for processing. With predefined threshold values, the microcontroller decides whether the light is red, yellow, or green. After the color is identified, the system gives voice output via a voice-assist module, saying ”Red Light”, ”Green Light” or ”Yellow Light.”

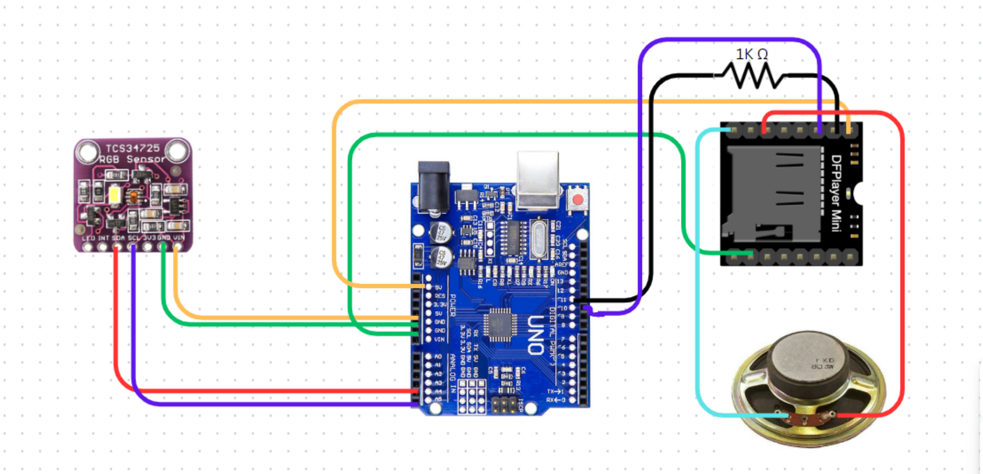
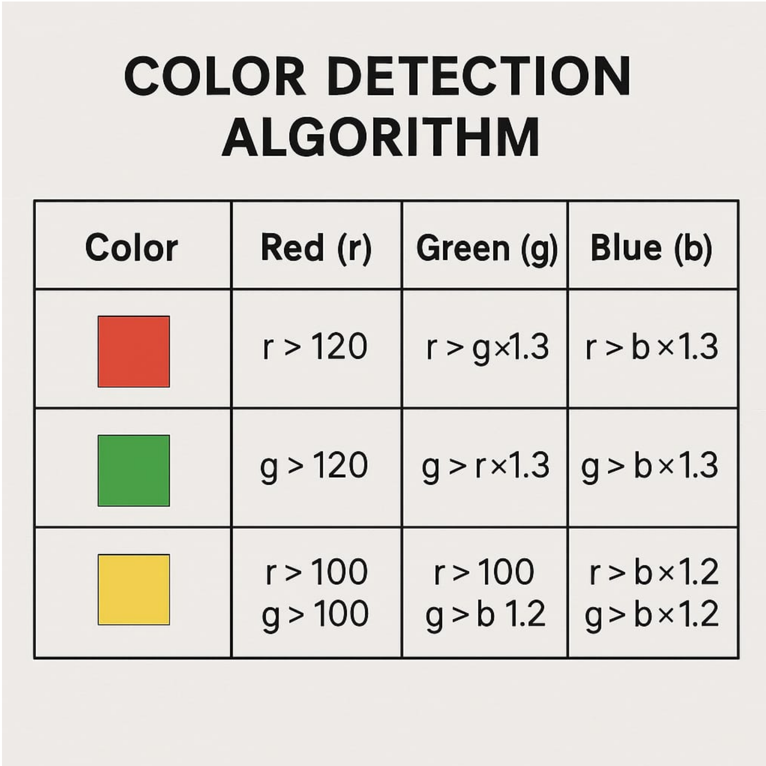


Figure 4.1: Circuit Diagram

For increased usability, the system is made portable, light, and comfortable to wear. The voice output guarantees that colorblind people can travel safely across roads without depending on visual information alone. The device is adjusted to work effectively under varying lighting conditions, and it is a cost-effective and reliable solution for road safety and accessibility.



COLOR DETECTION ALGORITHM

Color	Red (r)	Green (g)	Blue (b)
	r > 120	r > g×1.3	r > b×1.3
	g > 120	g > r×1.3	g > b×1.3
	r > 100 g > 100	r > 100 g > b 1.2	r > b×1.2 g > b×1.2

Figure 4.2: Colour Detection Algorithm

Chapter 5

Results and Discussion

The Traffic Light Recognition Glasses for Colorblind People was able to show that it can recognize traffic light colors and give real-time audio feedback. The RGB color sensor can sense red, yellow, and green colors when held close to the traffic light simulation. The Arduino-based processing unit was able to process data from sensors effectively, making the DFPlayer Mini voice module say the colors that were sensed.

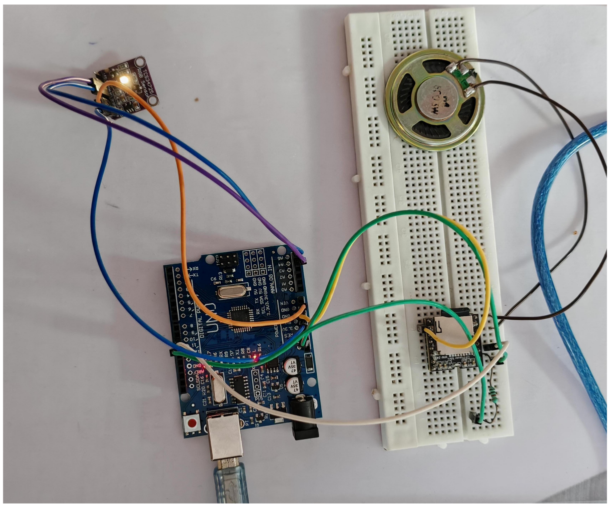


Figure 5.1: Hardware

Although effective as a proof of concept, there were some limitations found. The system is based on close-range detection, so it cannot yet identify actual traffic lights at a distance. Also, changing ambient light conditions impacted sensor readings, necessitating sensitivity adjustments. Overall, the project was able to show a cost-effective and accessible assistive device that can potentially enhance mobility and safety for colorblind people.

Chapter 6

Conclusion

Traffic Light Recognition Glasses for Colorblind People was successfully designed and implemented to help color vision deficient individuals recognize traffic lights. The system has an RGB color sensor to identify traffic light colors and a voice-assist module to voice out the respective signals in real-time. This solution removes the problem of colorblind people in recognizing traffic lights, providing safer and more independent travel on roads.

The main objective of this project was to develop a cost-effective, affordable, and easy-to-use solution that improves road safety for colorblind people. With real-time audio feedback, the system enables users to confidently understand traffic lights without the need for external support. The design is focused on portability and ease of use, and hence it is an efficient assistive tool for everyday commuting.

Chapter 7

Future Scope

The Traffic Light Recognition Glasses for the Colorblind People is expandable from its initial usage to accommodate other users and functionalities. The potential scope involves its extension for increasing accessibility, fusion with emerging technologies, and conformity of the system for various uses.

1. AI-Based Image Recognition and Smart Sensors – Merging a camera with AI and deep learning can enhance traffic light recognition, road sign identification, and pedestrian protection. LIDAR or infrared sensors can improve obstacle detection.

2. Visually Impaired and Elderly User Assistance – Incorporating ultrasonic sensors for obstacle detection and real-time voice instructions can assist blind and elderly pedestrians in navigating roads safely.

3. IoT and Smart Connectivity – Integrating the system with GPS, mobile apps, and intelligent traffic lights can enable real-time traffic information, navigation, and emergency notification.

4. Smart Helmet and Wearable Tech Integration – The system can be integrated into bikers' and cyclists' helmets, providing heads-up displays (HUDs) and voice notifications for improved safety.

5. Multi-Language and Customizable Alerts – Diversifying voice output to numerous languages, so users can vary alert volume and frequency, as well as activating gesture or voice control for ease of use.

6. Vehicle-to-Infrastructure (V2I) Communication – The system would be able to communicate with smart city infrastructure as well as traffic signals to make real-time traffic management and pedestrians' and drivers' safety enhanced.

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Appendix A

Programming Code

```
#include <Wire.h>
#include ”Adafruit_TCS34725.h” // RGB Sensor Library
#include <SoftwareSerial.h>
#include <DFRobotDFPlayerMini.h>

    // Initialize RGB Sensor
Adafruit_TCS34725 tcs =
Adafruit_TCS34725(TCS34725_INTEGRATIONTIME_600MS, TCS34725_GAIN_1X);

    // DFPlayer Mini (MP3 Module) using Software Serial SoftwareSerial mySe-
rial(10, 11); // RX, TX6 DFRobotDFPlayerMini mp3;
int lastPlayed = 0; // Prevent repeated audio playback
void setup()

Serial.begin(9600);
mySerial.begin(9600);
// Initialize RGB Sensor
if (!tcs.begin())

Serial.println(”Sensor not found! Check wiring.”);
while (1); // Stop execution if sensor is not found
```

```
Serial.println(”RGB Sensor Connected!”);
// Initialize MP3 Module
if (!mp3.begin(mySerial))

Serial.println(”DFPlayer Mini not found! Check wiring.”);
while (1);

Serial.println(”MP3 Module Connected!”);
mp3.volume(30); // Set volume (0 to 30)

void loop()

uint16_t red, green, blue, clear;
tcs.getRawData(&red, &green, &blue, &clear);
// Prevent division by zero
float r = (clear > 0) ? ((float)red / clear * 255.0) : 0;
float g = (clear > 0) ? ((float)green / clear * 255.0) : 0;
float b = (clear > 0) ? ((float)blue / clear * 255.0) : 0;
// Display values on Serial Monitor
Serial.print(”Red: ”); Serial.print(r);
Serial.print(” Green: ”); Serial.print(g);
Serial.print(” Blue: ”); Serial.println(b);
// Color Detection Logic
if (r > 120 && r > g * 1.3 && r > b * 1.3)

Serial.println(”Red Light Detected”);
if (lastPlayed != 1)

mp3.play(1);
lastPlayed = 1;
```

```
else if (g > 120 && g > r * 1.3 && g > b * 1.3)

Serial.println(”Green Light Detected”);
if (lastPlayed != 2)

mp3.play(2);
lastPlayed = 2;


else if (r > 100 && g > 100 && r > b * 1.2 && g > b * 1.2)

Serial.println(”Yellow Light Detected”);
if (lastPlayed != 3)

mp3.play(3);
lastPlayed = 3;


else

Serial.println(”No Traffic Light Color Detected”);
lastPlayed = 0;

Serial.println(”——————————-”);
delay(1000); // Wait before next detection
```