Color sensor prototype using Artificial Neural Network

Design Lab Report

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Abstract:

This project aims to create a RGB colour sensor using TCS3472 colour sensor and Arduino Nano using MLP technique to expand the colour detection to different shades of Red, Green, and Blue. This prototype is small is size thus easily mountable on any spectacles, making it convenient for colour blind individuals to detect colour.

Similar to colour vision of eye, the RGB model comprises more than 16 million colours, which are arrange in a 3D space, where integer values of components R(red), G(Green), B(Blue), ranging from 0 to 255, constitute coordinates of this space, from this model, colour detection and recognition were performed with light-related electronic components and Deep learning mechanisms.

Color recognition was performed with Multilayer Perceptron (MLP) - an architecture of Artificial Neural Networks (ANN). It allows classification and recognition of spatially separable patterns - very useful in this case.

This is comparable to outliers or distorted patterns, which may affect precision in the recognizing task; regarding feature (RGB) space, a misclassified color should be interpreted as a coordinate located at spatial regions associated to another color (sometimes due to poor generalization, overfitting, and many other possibilities.)

Multi-Layer Perceptron is a feedforward architecture of ANNs, having an input (non-neural) layer, hidden layers, and an output layer. This network is trained by backpropagation algorithm, performing supervised learning (learning by examples).

For this color sensor, the neural network receives 3 inputs (RGB values), having two hidden layers with 15 and 10 neurons respectively and an output layer with 3 neurons since the output layer must have the same number of classes (colors, in this case), for a binarized output. Hidden-layer sizes are empirically obtained, establishing ranges of values for each topological parameter, so that approaches for Hyperparameter optimization may find potentially good results (this can be a bit difficult and slow sometimes), so it is possible to input values at training tab and check the outputs.

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Motivation

The motivation behind this project stems from the desire to improve the quality of life for individuals with colour vision deficiencies. Colour blindness is often overlooked in technological advancements, despite its significant impact on daily activities and social interactions. By developing an RGB colour sensor, this project aims to address this gap and provide a practical solution to assist colour blind individuals in perceiving colours accurately.

Existing colour vision aids, such as colour correction glasses, have limitations in terms of accessibility and effectiveness. Moreover, these solutions may not be suitable for all types of colour blindness or may require ongoing maintenance. In contrast, an RGB colour sensor offers a portable, cost-effective, and customizable solution that can be easily integrated into various devices or applications.

The sensor's primary function is to accurately detect and differentiate between various colours, providing valuable visual information to the user.

By providing real-time feedback, this device aims to enhance the quality of life for those with colour vision deficiencies.

Design methodology

The design and development of the RGB colour sensor involves a series of systematic steps aimed at integrating hardware components, programming functionalities, and online data display systems to streamline the colour detection process. The methodology encompasses the following key phases:

Sensor Selection: The initial phase of development involved choosing a suitable RGB sensor module capable of accurately detecting red, green, and blue light wavelengths.

Hardware Design: Designing the electronic circuitry to interface the RGB sensor with a microcontroller or embedded system. It involved connecting the circuit components and collecting data accordingly.

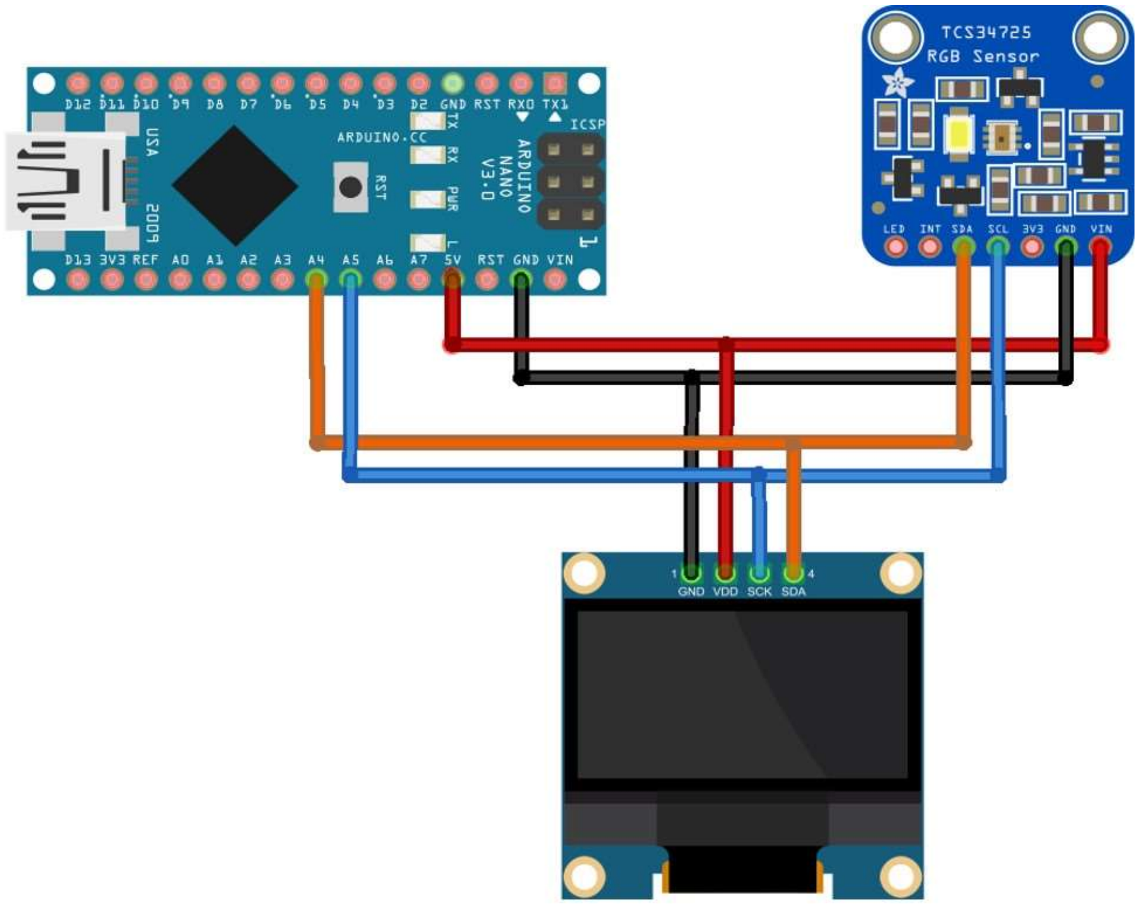
Software Development: Developed software algorithms to process the sensor data and classify colours based on their RGB values, used coolterm software to integrate with my computer serial monitor to facilitate the data collection.

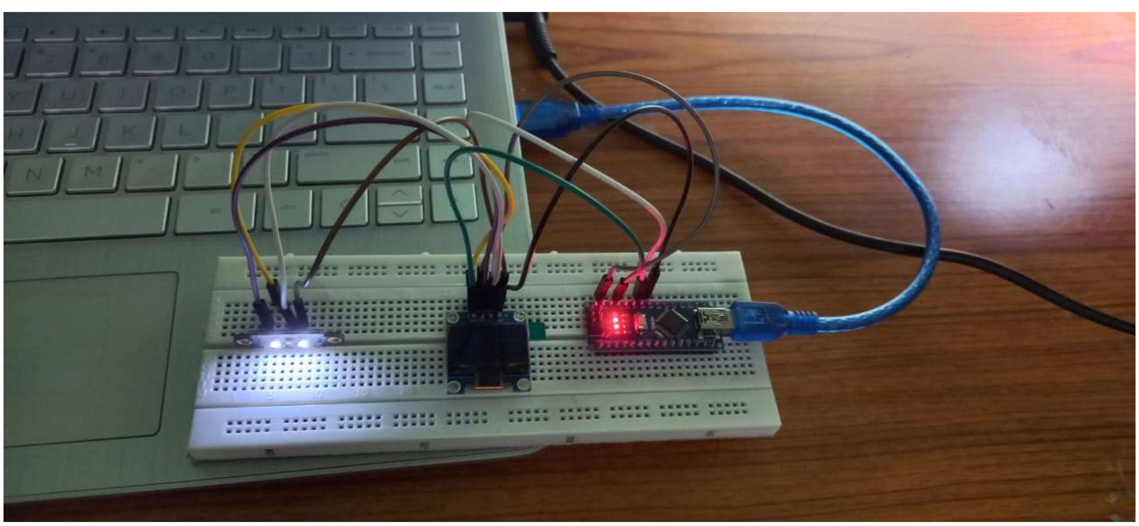
Calibration: Calibrated the sensor to account for variations in ambient light conditions and ensure consistent colour detection accuracy.

User Interface: Designing a user-friendly interface using an OLED display, to present colour information to the user in real-time.

Testing and Evaluation: Conduct thorough testing to assess the sensor's performance in detecting and distinguishing between different colours, including those commonly problematic for colour blind individuals, testing includes a 5-fold cross validation to test data and chose the weights that give the best results.

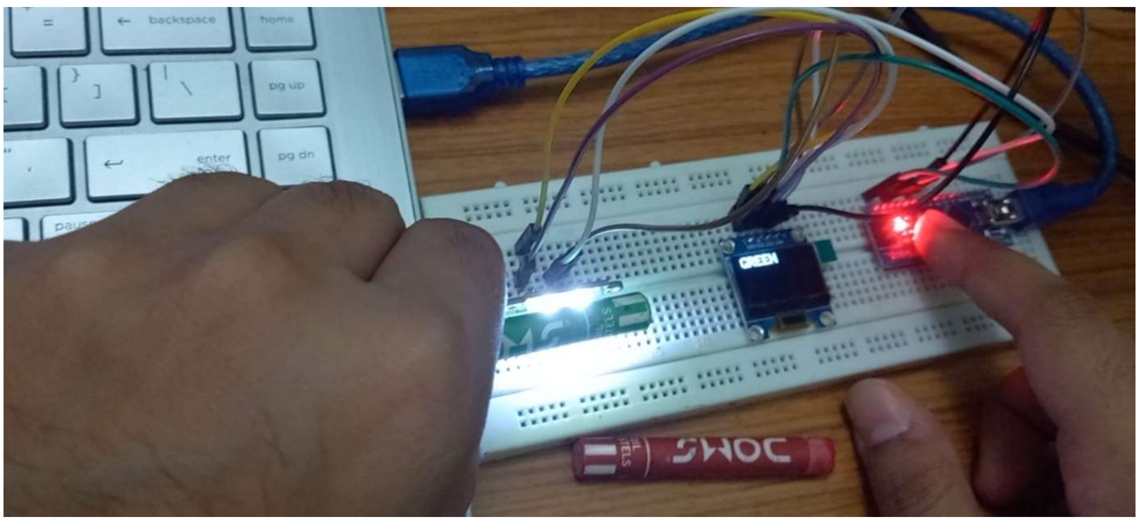
Design System diagram

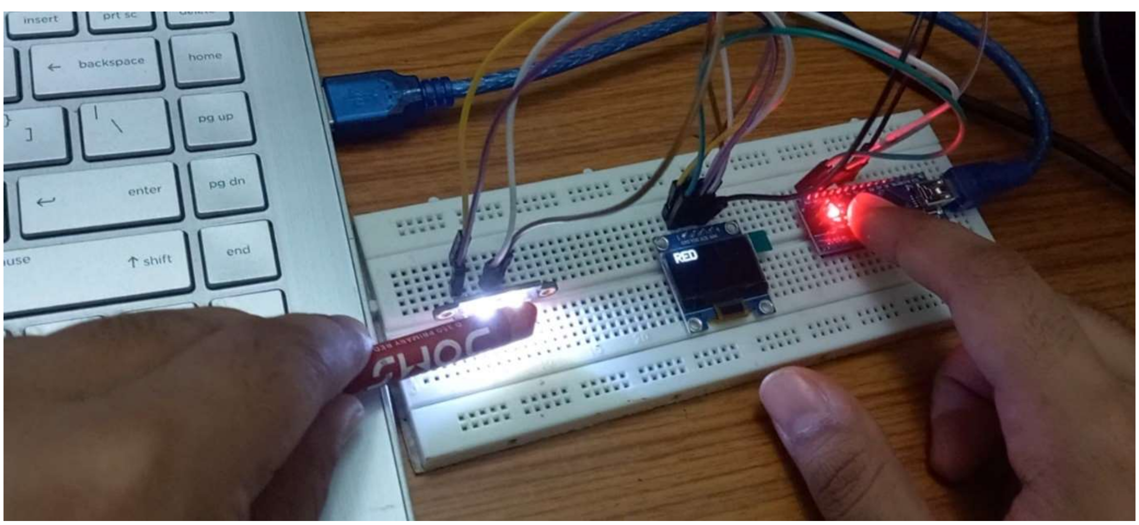


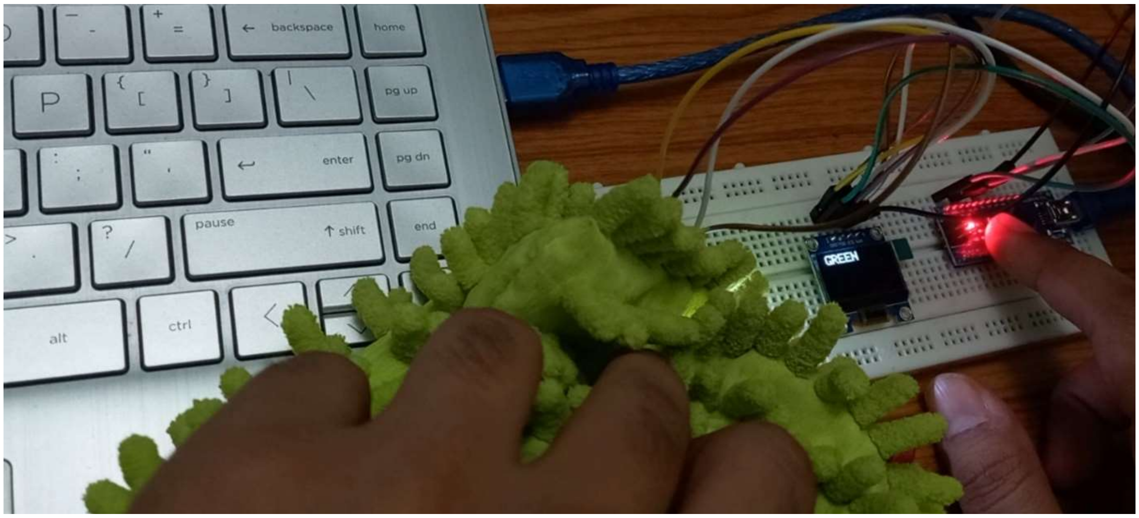


Results and discussion

The development of an RGB colour sensor holds promise as a valuable tool for assisting colour blind individuals in perceiving colours accurately. By leveraging advances in sensor technology and signal processing, we can create a reliable and accessible solution to address the challenges faced by individuals with colour vision deficiencies. Future research may focus on refining the sensor's design, enhancing its usability, and exploring additional features to further improve its effectiveness in real-world scenarios.



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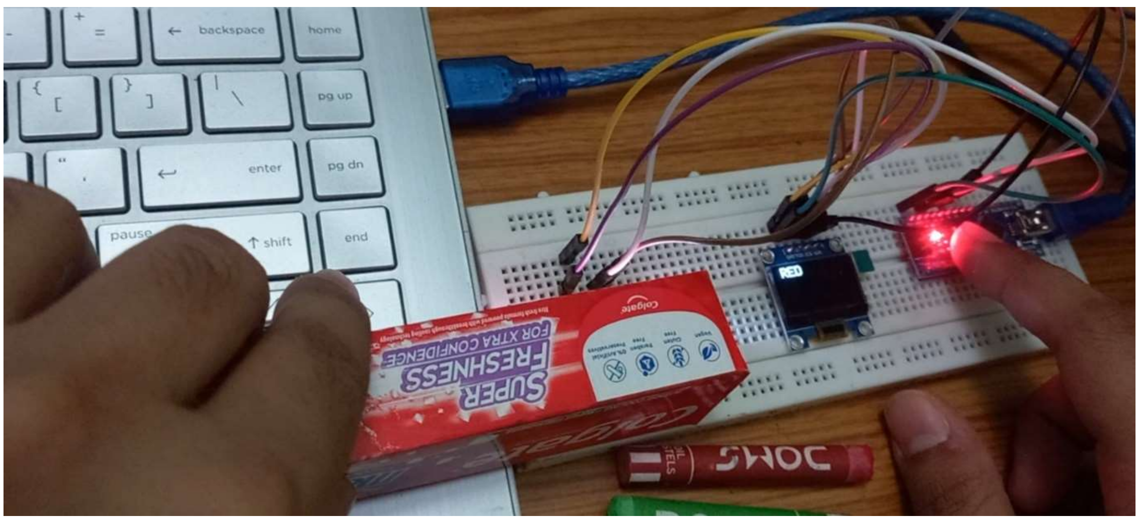
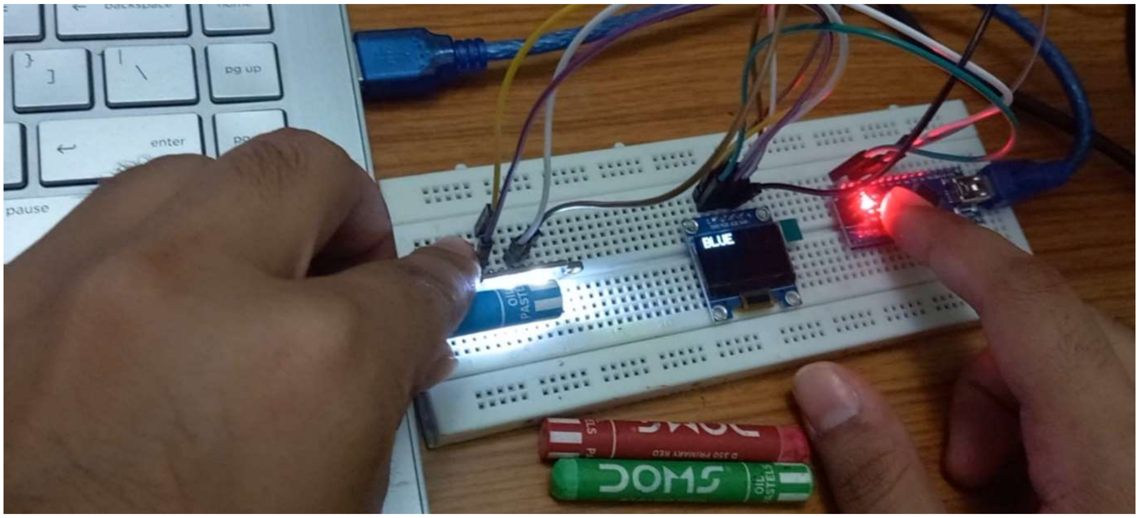

RED


BLUE
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OIL PASTELS
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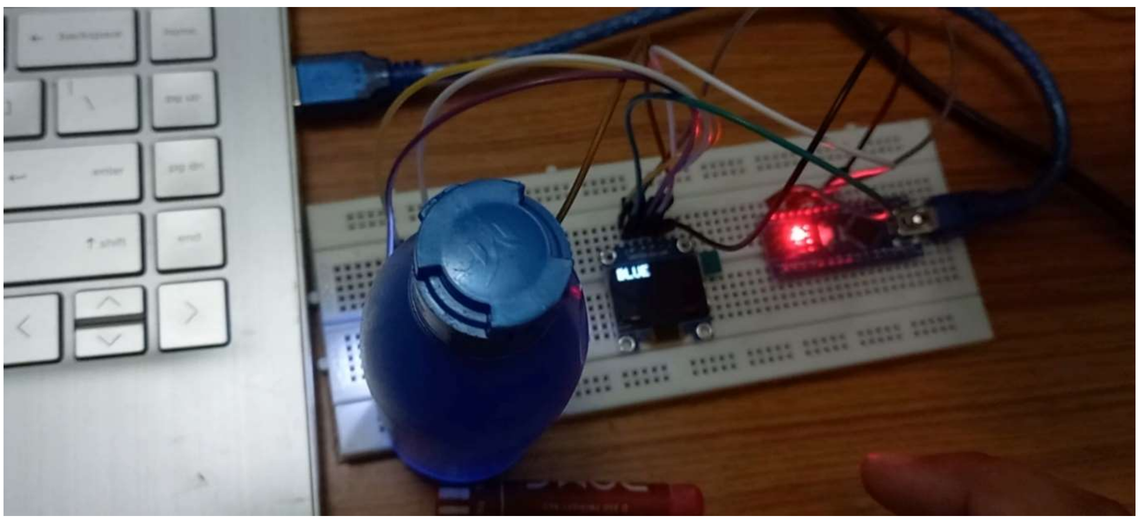
BLUE

Future scope of extension

While the initial development of the RGB color sensor represents a significant advancement in assisting color blind individuals, there are several avenues for future research and extension to enhance its functionality and impact. The following are potential areas of exploration for extending this project:

1. **Integration with Wearable Technology** Explore the integration of the RGB color sensor into wearable devices, such as smart glasses or wristbands. This would provide users with a more seamless and hands-free experience, allowing for continuous color detection and feedback in various environments.

2. **Machine Learning Algorithms:** Investigate the implementation of machine learning algorithms to improve color classification accuracy and adaptability. By training the sensor with a diverse dataset of color samples, it can learn to recognize subtle variations and nuances in colors, thereby enhancing its overall performance.

3. **Customization for Specific Color Blindness Types:** Develop customization options within the sensor's software interface to cater to different types and severities of color blindness. Users could select specific color correction modes tailored to their individual needs, ensuring optimal assistance for their unique color perception challenges.

4. **Enhanced Accessibility Features:** Incorporate accessibility features into the sensor's user interface, such as voice-guided instructions or tactile feedback for users with visual impairments. Additionally, explore compatibility with screen readers and other assistive technologies to ensure inclusivity and ease of use for all individuals.

5. **Real-Time Color Identification:** Implement real-time color identification capabilities using image processing techniques. By integrating a camera module with the RGB sensor, the device could analyze live video feeds and provide instant feedback on the colors of objects in the user's surroundings.

6. **Mobile Application Development:** Create a dedicated mobile application to complement the RGB color sensor, offering additional features such as color naming, color matching, and personalized color profiles. The app could also serve as a platform for community engagement, allowing users to share their experiences and feedback with others.

7. **Expansion of Use Cases:** Explore new use cases and applications for the RGB color sensor beyond assisting individuals with color blindness. For example, the sensor could be utilized in industrial

settings for quality control in manufacturing processes or in educational settings to facilitate hands-on learning experiences in science and art.

8. **Collaboration with Healthcare Professionals:** Collaborate with healthcare professionals and researchers to conduct clinical studies and trials to evaluate the efficacy and usability of the RGB color sensor in real-world settings. This collaboration could provide valuable insights into the device's impact on improving the quality of life for individuals with color vision deficiencies.

In summary, the future scope of extension for the RGB color sensor project encompasses a wide range of opportunities for innovation and refinement. By leveraging emerging technologies and collaborating with diverse stakeholders, we can continue to advance the development of assistive devices that empower individuals with color blindness to perceive and interact with the world more effectively.

References

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