VISION CARE FOR KIDS:Vision Care for Kids: A Smart Spectacle System to Prevent Close-Distance Screen Exposure in Children.

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2. Abstract

Excessive mobile phone usage among young children, especially those below five years, has raised serious concerns regarding eye health. One of the major issues is close-distance viewing, which can negatively affect vision development. This paper proposes a smart wearable system named *Vision Care for Kids*, designed to maintain a safe viewing distance between the child's eyes and digital screens. The system utilizes an ultrasonic sensor to continuously monitor the distance and an Arduino-based controller to process the data. When the detected distance falls below a predefined safe threshold, a servo motor activates a vision-blocking mechanism. Once a safe distance is restored, normal vision is allowed. The proposed system is simple, cost-effective, and child-friendly, promoting healthy viewing habits without causing discomfort. Experimental observations indicate that the system effectively prevents harmful viewing behaviour and supports early eye care.

3. Keywords

Vision Care, Arduino, Ultrasonic Sensor, Servo Motor, Eye Protection, Smart Wearable

4. Introduction

4.1. Background of the Problem

In recent years, the use of smartphones among young children, especially those below the age of five, has increased significantly. Many children spend extended periods watching videos or engaging with digital content on mobile devices. Due to a lack of awareness and guidance, children often hold these devices very close to their eyes.

At such an early age, children's visual systems are still in the developmental stage, making them highly sensitive to external factors. Continuous exposure to screens at a short viewing distance places excessive strain on their eyes, potentially leading to blurred vision, eye fatigue, and early onset of vision-related problems. Since children are unable to recognize or correct unsafe viewing habits on their own, this issue has become a growing concern for parents and healthcare professionals.

4.2. Importance of the Study

This study is important as it addresses a critical and emerging health concern related to early childhood vision care. With the increasing dependency on digital devices for entertainment and learning, ensuring safe usage practices has become essential.

The proposed solution focuses on preventing harmful viewing behavior in a proactive and automated manner. By introducing a system that monitors viewing distance and intervenes, when necessary, the study promotes healthy visual habits among children without requiring constant supervision.

Furthermore, this work contributes to the development of assistive technologies that are child-friendly, non-intrusive, and effective. It helps reduce the risk of long-term eyesight problems, supports healthy eye development, and provides a practical solution for parents to safeguard their children's vision in a technology-driven environment.

4.3. Objectives of the Work

The main objectives of this project are:

• To design and develop a smart vision care system that monitors the distance between a child's eyes and a mobile screen in real time.

• To prevent children from viewing screens at unsafe distances by automatically blocking vision when necessary.

• To promote healthy screen-viewing habits among young children through a non-invasive and user-friendly approach.

• To reduce the risk of early vision problems caused by prolonged close-distance screen exposure.

• To implement a reliable system using components such as an ultrasonic sensor, Arduino controller, and servo motor.

• To ensure the system operates smoothly without causing discomfort or fear to the child.

5. Literature Review (Related Work)

5.1 Existing Research on Screen Exposure in Children

Several studies have highlighted the negative impact of excessive screen exposure on young children. Research in pediatric ophthalmology indicates that prolonged use of smartphones and tablets at a close viewing distance can lead to digital eye strain, myopia (short-sightedness), and other visual discomforts. Experts emphasize that children under the age of five are particularly vulnerable, as their eyes are still developing and more sensitive to environmental stress.

In addition, guidelines from health organizations recommend maintaining a safe viewing distance and limiting screen time for children. However, these recommendations rely heavily on parental supervision, which may not always be consistent or effective.

5.2 Existing Technological Solutions

Various technological approaches have been proposed to address screen-related eye issues:

• **Screen Time Monitoring Applications:** Mobile applications are available to track and limit screen usage time. While these apps help reduce overall exposure, they do not monitor the distance between the eyes and the screen.

• **Blue Light Filtering Glasses and Software:** Blue light filters are widely used to reduce eye strain caused by prolonged screen exposure. However, they do not address the issue of unsafe viewing distance.

• **Posture Detection Systems:** Some systems use cameras or sensors to detect posture and viewing habits. These are often complex, expensive, and not specifically designed for young children.

• **Parental Control Mechanisms:** Existing parental control tools allow content restriction and usage limits but lack real-time intervention for physical viewing habits.

5.3 Research Gap

Despite the availability of the above solutions, a significant gap still exists in ensuring **safe viewing distance** for children:

• Most existing solutions focus on **screen time** rather than **viewing distance**.

• There is a lack of **real-time automatic intervention systems** that can physically prevent harmful behaviour.

• Current technologies depend heavily on **manual supervision by parents**, which is not always reliable.

• Many solutions are **not child-friendly**, as they may cause discomfort or require complex setups.

5.4 Contribution of the Proposed Work

The proposed "Vision Care for Kids" system addresses these gaps by introducing a real-time, automated, and child-friendly solution. Unlike existing methods, this system:

• Continuously monitors the distance between the eyes and the screen using an ultrasonic sensor.

• Automatically intervenes by blocking vision when the distance becomes unsafe.

• Encourages healthy viewing habits without requiring constant parental monitoring.

• Provides a simple, low-cost, and non-intrusive solution suitable for young children.

Thus, this work bridges the gap between awareness and practical implementation by offering a proactive approach to protecting children's eyesight.

# 6. Methodology / Proposed System

6.1 Overview of the Proposed System

• The proposed system is an embedded, real-time vision protection solution designed to monitor and regulate the viewing distance between a child's eyes and a mobile screen. It integrates an ultrasonic sensor for distance measurement, a microcontroller for decision-making, and a servo-based actuation mechanism for physical intervention.

• The system continuously acquires distance data and compares it with a predefined safety threshold. When the measured distance falls below the acceptable limit, the controller triggers a mechanical response to restrict vision, thereby preventing unsafe screen exposure. Once a safe distance is restored, normal viewing is automatically resumed.

• This closed-loop system ensures continuous monitoring, rapid response, and minimal user dependency, making it suitable for practical and child-friendly vision care applications.

6.2 System Architecture

The system consists of the following main components:

• Ultrasonic Sensor: Measures the distance between the eyes and the mobile screen.

• Arduino Controller: Acts as the brain of the system, processing sensor data and making decisions.

• Servo Motor: Controls the movement of the blocking screen.

• Vision-Blocking Mechanism (Spectacle Frame): Temporarily blocks the child's vision when unsafe distance is detected.

6.3 Block Diagram (System Flow)
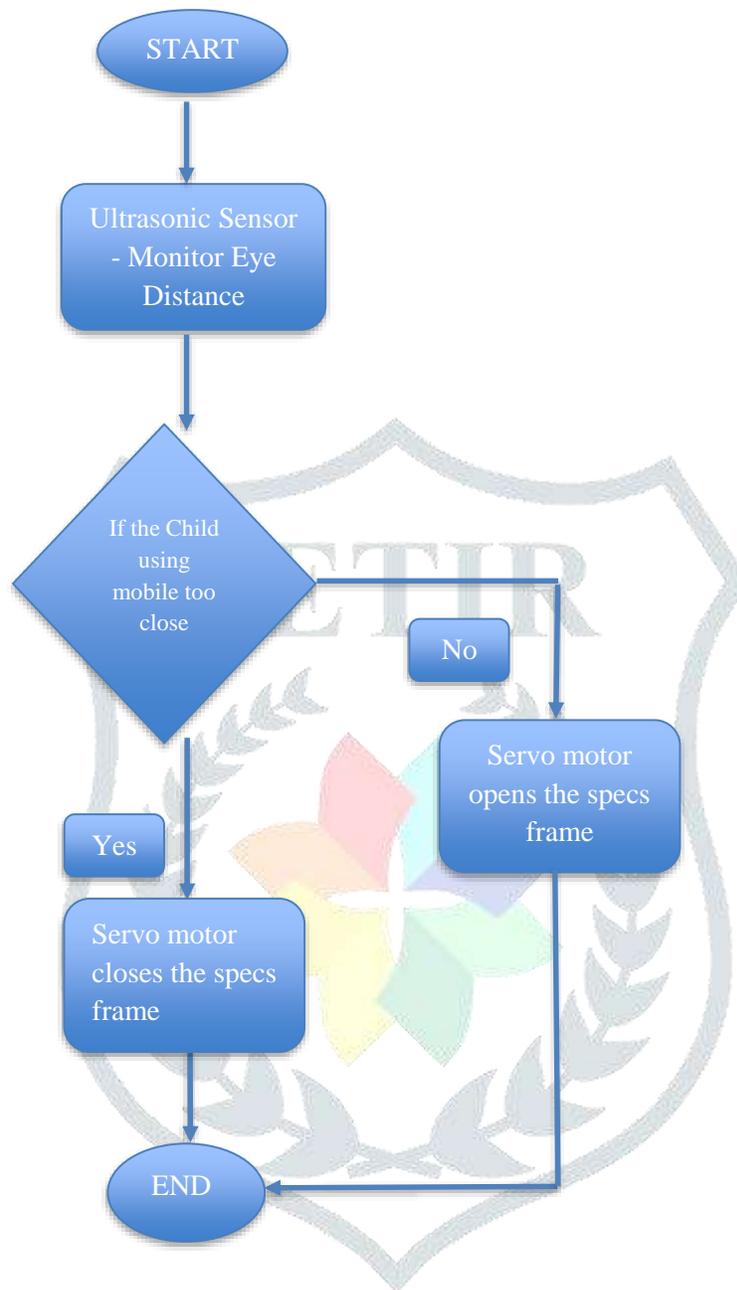
6.4 Working Principle

The working principle of the system is based on distance measurement and automated control:

1.　　　The ultrasonic sensor continuously emits sound waves and receives the reflected signals to calculate the distance between the child's eyes and the mobile screen.

2.　　　This distance data is sent to the Arduino controller for processing.

3.　　　The system compares the measured distance with a predefined safe threshold distance.

4.　　　If the distance is greater than or equal to the safe limit, the system allows normal viewing.

5.　　　If the distance is less than the safe limit, the Arduino sends a signal to the servo motor.

6.　　　The servo motor rotates to close the vision-blocking screen, preventing the child from viewing the screen.

7.   Once the child moves the device back to a safe distance, the sensor detects the change, and the servo motor reopens the screen.

This process operates continuously in real time to ensure consistent monitoring and protection.

7. Implementation

7.1 Hardware Implementation

The proposed system was implemented using a compact embedded setup integrated into a spectacle frame. The hardware components include an ultrasonic sensor, a microcontroller (Arduino), a servo motor, and a lightweight vision-blocking mechanism.

The ultrasonic sensor is mounted on the front side of the spectacles to continuously measure the distance between the child's eyes and the mobile screen. The sensor is connected to the Arduino, which processes the distance data in real time. Based on the measured values, the Arduino sends control signals to the servo motor.

The servo motor is mechanically attached to a small blocking screen (or flap). When activated, it rotates to cover the lenses and block vision. When the distance returns to a safe range, the servo motor repositions the screen to restore normal vision.

All components are powered using a portable power source, making the system wearable and user-friendly.

7.2 Circuit Diagram Description

The circuit connections are designed to ensure reliable communication between components:

- **Ultrasonic Sensor (HC-SR04):**

o VCC → 5V (Arduino)

o GND → GND

o TRIG → Digital Pin (e.g., D9)

o ECHO → Digital Pin (e.g., D10)

- **Servo Motor:**

o VCC → 5V (or external supply if needed)

o GND → GND

o Signal Pin → Digital PWM Pin (e.g., D6)

- **Arduino Board:** Acts as the central controller connecting all components. The circuit ensures continuous data acquisition from the sensor and precise control of the servo motor through PWM signals.

7.3 Software Implementation (Arduino Code)

The system is programmed using the Arduino IDE. The code is responsible for reading sensor data, calculating distance, and controlling the servo motor.

7.4 Key Functional Steps:

1.   Initialize sensor and servo motor.

2.   Trigger ultrasonic pulse and measure echo time.

3.   Convert time into distance (in cm).

4.   Compare with predefined safe distance.

5.   Control servo position accordingly.

7.5 Code:

```
#include <Servo.h>

const int trigPin = 9;
const int echoPin = 10;
const int servoPin = 6;

Servo myServo;

long duration;
int distance;
int safeDistance = 30; // in cm

void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  myServo.attach(servoPin);
  myServo.write(0); // Open position
  Serial.begin(9600);
}

void loop() {
  // Trigger ultrasonic sensor
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Read echo time
  duration = pulseIn(echoPin, HIGH);

  // Calculate distance
  distance = duration * 0.034 / 2;

  Serial.print("Distance: ");
  Serial.println(distance);

  // Decision making
  if (distance < safeDistance) {
    myServo.write(90); // Close (block vision)
  } else {
    myServo.write(0);  // Open (normal vision)
  }

  delay(200);
}
```

7.6 System Setup and Integration

The system is assembled in a compact and wearable format:

• All components are securely mounted on a spectacle frame.

• Wires are arranged to avoid discomfort to the user.

• The ultrasonic sensor is positioned for accurate forward distance measurement.

• The servo motor is aligned with the blocking screen for smooth operation.

After assembly, the system is calibrated by adjusting the safe distance threshold based on user comfort and testing conditions.

7.7 Testing and Validation

The system was tested under different distance conditions to ensure accuracy and responsiveness:

• At distances below the threshold, the blocking mechanism activated instantly.

• At safe distances, normal vision was maintained without delay.

• The system operated continuously with stable performance and minimal error.

8. Results and Discussion

8.1 Output of the Proposed System

The developed system was successfully implemented and tested to monitor and control the viewing distance between the user's eyes and a mobile screen. The system demonstrated accurate distance measurement using the ultrasonic sensor and effective actuation of the servo motor based on predefined conditions.

When the viewing distance was maintained above the safe threshold (30 cm), the system allowed normal vision without interruption. However, when the distance dropped below the threshold, the servo motor activated immediately and closed the vision-blocking mechanism, preventing further exposure. Once the safe distance was restored, the system automatically resumed normal operation.

8.2 Observations

The following observations were made during testing:

• The ultrasonic sensor provided consistent and reliable distance measurements within the operating range.

• The system responded quickly (within milliseconds) to changes in distance.

• The servo motor operated smoothly with minimal delay in both opening and closing actions.

• The blocking mechanism effectively restricted vision without causing discomfort.

• The system functioned continuously without significant performance degradation.

8.3 Experimental Analysis

The system was tested under different distance conditions to evaluate its performance. The results are summarized below:

Distance (cm)	System Response	Servo Action
> 30 cm	Safe Condition	Open (Normal Vision)
25 – 30 cm	Borderline Condition	No action / Stable
< 25 cm	Unsafe Condition	Close (Block Vision)

From the analysis, it is evident that the system reliably differentiates between safe and unsafe viewing distances and performs appropriate actions accordingly.

8.4 Performance Discussion

The proposed system effectively achieves its objective of preventing close-distance screen viewing. The integration of sensing, processing, and actuation ensures a real-time response mechanism.

Advantages observed:

- Real-time automatic intervention

- High reliability in short-distance detection

- Simple and cost-effective design

- Minimal user dependency

9. Conclusion

This paper presented the design and implementation of a real-time vision care system aimed at preventing unsafe screen-viewing habits among young children. The proposed system integrates distance sensing, embedded processing, and mechanical actuation to monitor and control the viewing distance effectively.

The experimental results demonstrate that the system can accurately detect unsafe viewing distances and respond immediately by restricting vision, thereby reducing the risk of eye strain and long-term vision problems. The system operates reliably in real time and provides a practical, user-friendly solution without requiring constant supervision.

All the stated objectives of the work have been successfully achieved. The system effectively monitors viewing distance, prevents close-range exposure, and promotes healthy viewing behavior. Hence, the proposed solution proves to be a feasible and impactful approach for early-stage vision care in children.

The blindfold remains open when the child maintains a safe viewing distance.

The blindfold closes automatically when the child holds the mobile too close.