Smart distance alert system with Blynk integration for safer gadget use

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ABSTRACT

Gadgets have certainly become an integral part of our daily lives. From smartphones and tablets to laptops and smartwatches, we rely on these devices to stay connected, entertained, and productive throughout the day. Excessive usage of gadgets for a long time and unhealthy habits will lead to health problems such as myopia. Using gadgets at a close distance is one of the most common unhealthy habits among gadget users, especially children. This study, called "smart distance alert system" is developed to address the unhealthy habit of using gadgets at a close distance. The developed prototype operates by measuring the distance between the user and the gadget screen using an ultrasonic sensor. The buzzer and vibration motor work as an alert system, activating when the distance is less than 50 cm. Parents or guardians will get notifications through the Blynk application. The entire prototype is controlled by NodeMicrocontroller unit.

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1. INTRODUCTION

Excessive usage of gadgets can lead to health problems especially towards the quality of our vision [1]. Moreover, digital screens used in gadgets emit blue light rays that is proven by laboratory studies to damage the retina in our eyes and hinder our vision permanently if our eyes are overly exposed to the blue light rays. It is even worse when this excessive exposure to blue light rays is combined with the habit of looking at the screens up close which happens regularly between individual of all ages especially among children and teenagers. This negative habit of using gadget at a close distance will cause people to experience eye fatigue, eye strain, and blur in the peripheral vision that can trigger the process of lengthening of the eye, a condition known medically as Myopia [2]. Poor posture is a significant contributing factor to neck pain, as it places excessive stress on the neck muscles and joints. Real-time postural biofeedback is a promising intervention for neck pain management, as it provides instant feedback on the body's posture and can help individuals adjust their posture to reduce pain and discomfort [3].

Based on several studies and advice from optical expertise it is said that the ideal distance to keep our eyes from the computer is at least 50 cm. One the most practical way to approximately measure this distance is to sit with the screen straight in front of you at arms' length. The US occupational safety and health administration (OSHA), advises between 20 and 40 inches (50-100 cm). With an average arm length of 25 inches (63.5 cm), it is possible to estimate the correct distance without the use of measuring equipment [4]. Hence, from this information, the condition 50 cm will be used in this project as the indicator whether they are using their device at a safe distance or the other way around.

The internet of things (IoT) is a component of the Industrial 4.0 technological platform. It involves the intelligent connection of smart devices, enabling items to perceive and communicate with each other through an internet network [5]. The Internet network serves as a medium for billions of devices, including the IoT, which is rapidly expanding as a new paradigm [6]. The IoT has various applications, including intelligent manufacturing [5], precision agriculture [7]-[9], healthcare monitoring [10], urban infrastructure management [6], home automation [11], [12], energy optimization [13], [14], and transportation [15].

Therefore, this project entitled "smart distance alert system with Blynk integration for safer gadget use" was created to design a device that will help to alert users if they are using their gadgets at an unsafe distance. This will help to fix the unhealthy habit of looking at the screen too closely and instill a healthy habit that allows them to use their gadgets in a healthier manner. This project focused more on the usage of electronic devices such as laptops and personal computers. The buzzer and vibration motors trigger when the ultrasonic sensor detects a distance of less than 50 cm. Online data monitoring can be done by using an IoT platform called Blynk, either through the Blynk website or the Blynk application on a mobile phone.

2. THEORITICAL BACKGROUND

The proposed project has been influenced by various research projects, each of which has focused on distinct aspects of fostering safe and healthy screen interaction. A research endeavor proposes the creation of a secure distance sensor for television watching, with the objective of guaranteeing that viewers maintain a suitable distance from the screen [16]. The passive infrared sensor (PIR) sensor detects the user movement while HC-SR04 ultrasonic sensor detects user proximity to the screen and alerts them if they are in close range. If the measured distance deviates from the permitted range, an output will be produced by an output device, such as a buzzer, to sound an alarm and notify the individual.

Additionally, [17] introduces a gadget resembling glasses designed to assess the distance at which individuals read on smartphones. It also notifies users when their eyes approach the screens too closely. The project utilized an Arduino Nano board, featuring a Microcontroller with the ATmega328, along with an HC-SR04 ultrasonic sensor and an SD card for recording distance data. The device aims to assist users in maintaining an optimal viewing distance to prevent eye strain and address potential health issues. However, mounting the gadget on the head is deemed impractical and not particularly suitable for everyday use.

An integrated real-time monitoring system was presented in [18] to address the issue of children's eyestrain during online learning. This project aims to develop a real-time system that can accurately measure the distance between the user's eyes and the screen. Additionally, it will monitor the ambient light intensity in the room. Furthermore, this technology is specifically engineered to precisely quantify the duration of time that children spend in front of the monitor. The cited studies differ in terms of their project aims, regulators, output methods, and notification modalities. An online survey including 941 responses from students enrolled in online classes was analyzed [19]. The COVID-19 pandemic has resulted in a significant rise in the use of electronic gadgets for online leisure and education. The objectives of this study were to determine the frequency of digital eye strain (DES), describe how people use devices, and investigate potential risk factors that may lead to DES. It emphasizes how important it is to teach people the value of minimizing their overall screen time and using ergonomic methods when viewing screens. To address and lessen the common problem of eye strain, legislators should take the initiative to limit how long students can take online courses and how long professionals can work online.

Previous research have failed to consider individuals with hearing impairments, particularly those who are deaf. Due to their auditory impairment, individuals are unable to perceive auditory signals, making notifications given through components such as a buzzer ineffective. As a result, the system has been modified to include vibration motors in order to improve the alert capabilities. The main goals of this project are to enable users to detect vibrations and receive notifications when using their laptop or personal computer at a hazardous proximity.

3. METHOD

This project consists of two parts: hardware and software. Hardware refers to the development of the device itself, including the circuit construction, printed circuit board (PCB) etching, and soldering processes. As for the software, it is focused on the program development, specifically during the simulation on Proteus, compilation, and NodeMicrocontroller Unit (NodeMCU) burning process. An IoT microcontroller unit (MCU) or development board is utilized for the purpose of prototyping. An IoT MCU or development board comprises energy-efficient processors that are compatible with several programming environments. These processors can gather data from sensors through firmware and transmit the data, whether raw or processed, to a local or cloud-based server [20], [21] and can be different devices when using a WiFi network. It was connected to Wi-Fi to store the sensed data in a cloud server [22], [23].

The flowchart of the programming process of the system is depicted in Figure 1. As the user begins using their device, the system will automatically start the process of being initialized. The ultrasonic sensor will detect how much distance between the user and the device they are using [24], [25]. The distance data that has been read by the ultrasonic sensor will be sent to Blynk to be stored. The system will then check whether the calculated distance between the user and their device is less than 50 cm or not. If the distance is less than 50 cm, the buzzer and the vibration motors will be turned on. However, if the distance is greater than 50 cm, the buzzer and the vibration motors will remain off. The data that has been collected by Blynk will be used for monitoring purposes.

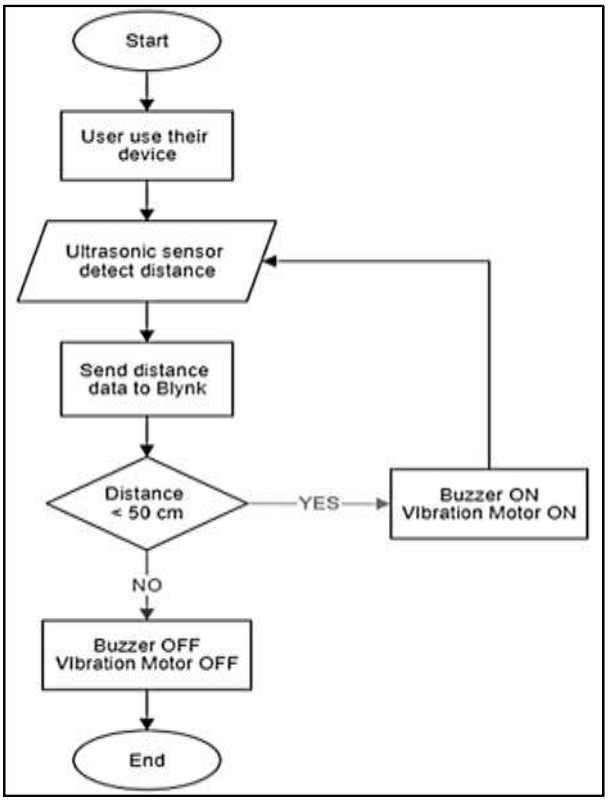


Figure 1. Flow chart of the system

4. RESULTS AND DISCUSSION

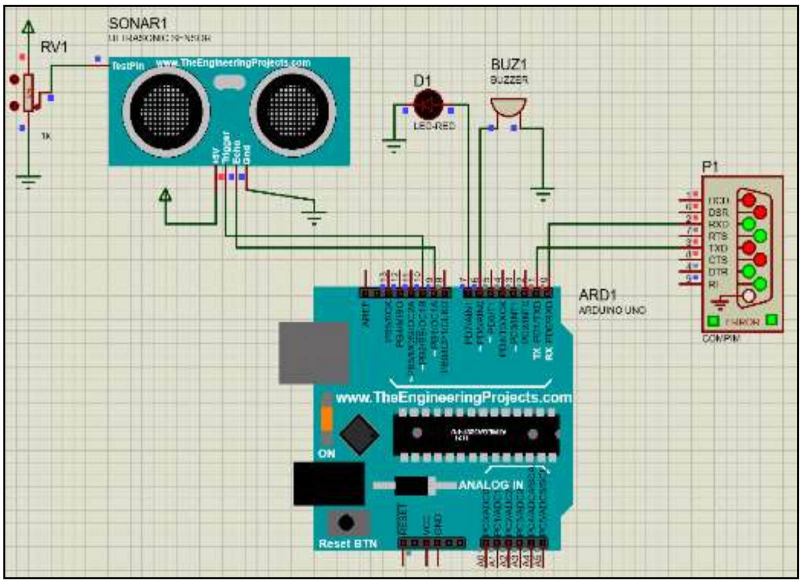
4.1. Simulation results

This project was used NodeMCU as its microcontroller. However, the available Proteus library for NodeMCU microcontroller only allows it to be used for schematic purposes because there is no option to incorporate the coding hex file from Arduino IDE into the NodeMCU microcontroller in the Proteus simulation program. In order to obtain the desired simulation output within the software, the NodeMCU microcontroller has been replaced with Arduino UNO microcontroller. Other than that, the vibration motor is also unavailable in the Proteus software simulation program. Neither the Proteus community nor the software's official developer team have created a library for this component. Therefore, the vibration motor has been represented by light emitting diode (LED) simply for simulation purposes.

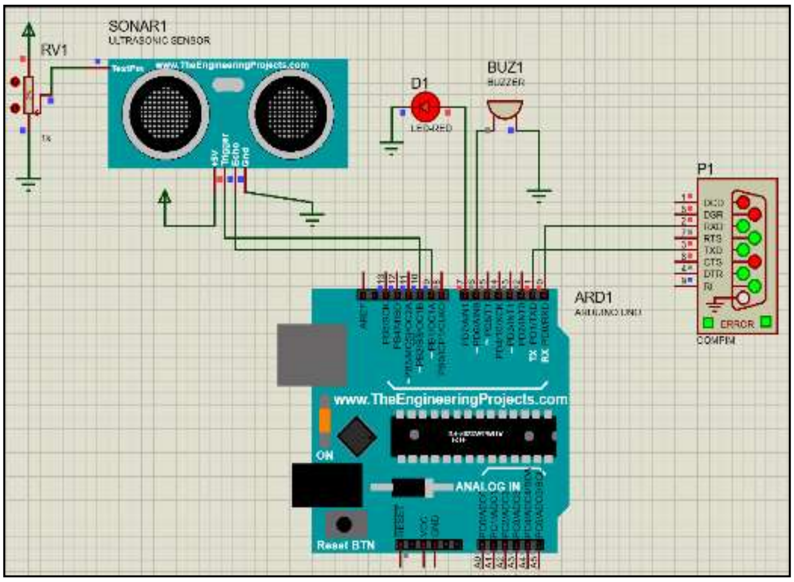
The potentiometer is connected to the ultrasonic sensor to act as a variable to give an input to the ultrasonic sensor. The ultrasonic sensor which acts as the input, and the output such as LED (represents vibration motor) and buzzer are connected to the Arduino UNO microcontroller through the digital input output pins. In Proteus, physical COM interfaces are modelled using COMPIM. In this circuit, COMPIM is connected to the Tx and Rx pin for the purpose of connecting the simulation circuit in Proteus with the Blynk IoT platform.

Figure 2 serves as the parent figure, providing an overview of the simulation results conducted under two different distance conditions. In Figure 2(a), the simulation outcome is illustrated with a distance value exceeding 50 cm, as detected by the ultrasonic sensor. In this scenario, both the LED (representing the vibration motor) and the buzzer remained inactive. The measured distance was then showcased on the liquid crystal display (LCD) widget within the Blynk application, accompanied by the message "Okay!" to confirm the user's compliance with a safe distance.

In contrast, Figure 2(b) showcases the simulation outcome when the ultrasonic sensor detected a distance value below 50 cm. As a response, both the buzzer and LED were activated. Similarly, the measured distance was displayed on the Blynk application's LCD widget, alongside the warning message "Too Close!" This alert signaled that the user was operating the device at an unsafe proximity. The distance data that has been stored in Blynk application can be analysed by using one of the available features in Blynk which is the graph feature as shown in Figure 3. The graph feature can show the live update of the distance value that has been read by the ultrasonic sensor. This feature can be used as a habit tracker that can assist the parents in monitoring their children's behaviour and habits when using laptop or computer.



(a)



(b)

Figure 2. Simulation output (a) distance more than 50 cm and (b) distance less than 50 cm

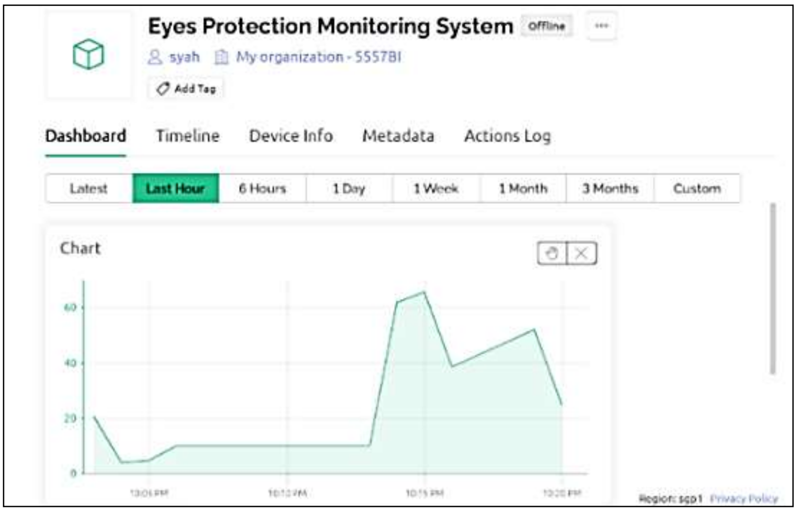


Figure 3. Data presentation on Blynk paltform for monitoring purposes

4.2. Hardware implementation results

Figure 4 shows the prototype of the “smart distance alert system” from the front view. The ultrasonic sensor can be seen to be protruding from the box to allow the sensor to accurately measure the distance between the user and the screen of their PC. Two pieces of small wooden clothespins have been attached to the prototype to allow the prototype to be mounted on the screen of the user’s PC. The small wooden clothespin has been chosen as the mounting mechanism to avoid the pressure from the clothespin being too harsh on the LCD screen of the PC, which can cause faulty to the LCD screen of the PC.

Figure 4. Smart distance alert system prototype

4.3. Data analysis

Data analysis has been made through 3 prototype testing to examine the functionality of the system. The first analysis from 1st testing is made to ensure the system works appropriately based on the distance range that has been set for the system. Two conditions were checked for this first analysis. The first condition is when the distance detected by the ultrasonic is more than 50 cm, and the other condition is when the distance detected by the ultrasonic is less than 50 cm. As demonstrated in Table 1, the system has been validated to function as intended. When the distance is detected above 50 cm, both the buzzer and vibration motors will remain deactivated. In contrast, in the situation where the distance detected is below 50 cm, the buzzer will emit a sound, and the vibration motors will initiate vibration. Another set of data analysis has been carried out, which consists of five readings for each and every set of distances. After that, the readings will be utilized in order to ascertain the average reading for each of the distances. Table 2 shows the outcome of the 2nd testing.

Table 1. Analysis based on system condition

Distance condition	Vibration motor	Buzzer
Distance > 50 cm	No vibration produced	No sound produced
Distance < 50 cm	Vibrates	Produces sound

Table 2. The average reading of five data sets

Measurement No.	Reading 1 (cm)	Reading 2 (cm)	Reading 3 (cm)	Reading 4 (cm)	Reading 5 (cm)	Average (cm)
1	40	40	40	41	40	40.2
2	50	50	49	50	49	49.6
3	59	59	60	59	60	59.4
4	69	68	68	69	68	68.4
5	73	74	74	75	74	74.0

The percentage error and accuracy of this system are then determined in 3rd testing. This prototype testing is a continuation of the previous testing. In this testing, the actual distance value measured using a ruler was compared to the average distance value that the ultrasonic sensor has read in previous experiments. Prior to performing this experiment, the laptop lid had been adjusted to open at a 90-degree angle. This is to ensure that the measurement of the real distance measured with the ruler is more precise. The results of the 3rd testing are reported in Table 3, which comprises the data analysis between the average reading value and the actual distance value. According to the figures for the percentage error, it is clear that the system has a slight error in its readings. Furthermore, based on the percentage accuracy, the system can be said to have high accuracy.

Table 3. Data analysis on average reading value and actual value

Actual Distance (cm)	Average (cm)	Error (%)	Accuracy (%)
40	40.2	0.50	99.50
50	49.6	0.80	99.20
60	59.4	1.00	99.00
70	68.4	2.29	97.71
75	74.0	1.33	98.67

5. CONCLUSION

In conclusion, the smart distance alert system has been effectively developed to monitor and alert users regarding their close-distance gadget habits. The addition of a vibration motor ensures that even individuals with hearing impairments can utilize the device, distinguishing it from conventional systems that rely solely on audible alerts for eyes-to-screen distance monitoring. Furthermore, by integrating the distance data feature of the Blynk app, parents can monitor their children's laptop usage effectively. This effort has the potential to benefit our community positively.

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