Standard Distance Detector Tool for TV users based on Fuzzy Decision Tree

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Abstract. Eye health is a very important thing, so it is fitting that we take good care of it. With the frequent viewing of television programs, we should be able to maintain eye health from the effects of light released by a TV tube that can make our eyes tired quickly which can interfere with daily activities. This standard distance detector device based on microcontroller TV users is designed and uses ultrasonic sensors and PIR sensors as detectors, so that it can anticipate fatigue in the eye due to television viewing distance that is too close. The design of this tool uses the literature study method, by conducting library research to obtain a theoretical foundation from supporting books, internet, articles, journals and exchanging ideas with people who are experienced in the field of electronics. The results of the design of a Standard Distance Detector Microcontroller-based TV Users are devices that can measure and detect safe distances for the eyes in watching television activities, based on the size of television resolution. With the security of using electronic equipment that has been designed, so that in its implementation can minimize cases of damage to eye health in the general public as a whole.

1. Introduction

TV is often used as a scapegoat to damage the sense of sight in children who like watching TV. When sitting and watching close to the TV can cause eye strain and fatigue, watching TV in the wrong lighting can also cause eye strain. Sitting too close to the TV does not cause permanent damage to the eye but it causes eye strain and fatigue according to the Canadian Optometrist Association. At least there are some recommendations from CAO that you can do to minimize the effects of any type of TV lighting. Watching television has rules that must be obeyed if you don't want bad effects to approach. One of them is the distance of the television monitor screen to the eye must follow the standard calculation that applies internationally. The distance between the television screen and the audience is 5 times the screen diagonal (for tube television). For this reason, the distance to watch television must follow the calculation of internationally recognized standards.

Distance sensors from previous researchers are used as the reference of standard distance detector TV users. Several researchers have used proximity sensors to measure distance. Miah examined unique smart glasses for people with the visual disorder. The glasses detect obstacles and measure distance perfectly using ultrasonic sensor and microcontroller. SIM900A GSM/GPRS module was used to collect information from the internet [1]. Hatthasin examined measuring wheel speech for the blind. The work...
aimed to design and make a prototype of a low-cost speech measuring wheel for individuals with visual impairments. By providing a Braille appearance and stating the distance traveled, the proposed device helps educate the blind to understand the concepts of distance and measurement [2].

Razvan-Daniel designed non-contact scouts using flexible and inexpensive ultrasonic. These scouts can be used in a variety of applications, such as toxic environments, hard-to-reach spaces, electromagnetic-polluted environments, etc. The core of the scout was the Atmega 328 P-PU microcontroller, which has an RISC architecture, a 32 8-bit register, namely sufficient resources to implement a highly accurate cost-effective product [3]. Tianyu researched a control method to prevent falls from the treadmill based on STM32 microcontroller and ultrasonic transducer. Treadmills have been widely used in homes or health entertainment centers; safety is very important. If the body's gait is not appropriate or the level of body tendency is too large, it causes movement instability. The intelligent electronic control method was based on the STM32 microcontroller and ultrasonic transducer, which automatically control the speed of the treadmill in real-time through detection of upper body position or the tilt angle of the human body [4].

The real-time embedded system for accident prevention was investigated by John. It was autonomous accident prevention with techniques that allow safety, speed control and accident detection system. The proposed system consisted of two separate design units: the transmitter unit, and the receiver unit. The security system included alcohol sensors, eye sensors and smoke sensors. The piezoelectric sensor will detect the signal, and send it to the ATmega328P microcontroller [5]. An analysis of the performance of laser distance finder and blue LEDs for Autonomous Underwater Vehicles (AUV) was carried out by Aras. The new technique for avoiding obstacles or depth control used a laser range finder and blue LED and was then applied to the Autonomous Underwater Vehicle (AUV). The finder was to measure and detect obstacles in a certain range. The components used were Arduino Nano as a microcontroller, 5 mm blue LED (receiver) and LRF (transmitter) able to focus on depth control [6].

The design and implementation of traffic signs and barriers detection on self-driving cars using SURF detectors and brute force matching were examined by Renjith. One of the most amazing innovations of smart city traffic management and control is the increasing technological advancements in the field of automatic vehicles. This is made possible through an image matching algorithm using a combination of SURF detectors, brute force matching and RANSAC. This feature matching algorithm was preferred because it depended at least on the lighting conditions and rotation or tilt [7]. Papa investigated the detection of obstacles and start sensor integration for small unmanned aircraft systems. Barrier detection and attitude estimation for small quadrotors using low-cost sensors, namely the Sonic Ranging Sensor (SRS) and InfraRed Sensor (IRS), widely used in mobile applications for short distance measurements, were controlled and managed by a microcontroller (Arduino Mega 2560) and synchronized on 2-Hz sampling [8].

The development of autonomous robots for inspection systems was investigated by Saat. The system was equipped with an Inertial Measurement Unit (IMU) sensor that measured the orientation and direction of the robot, and a rotary encoder that measured the distance traveled by the robot. Proportional Derivative (PD) controller was applied for the autonomous navigation system. The feedback signals from the IMU sensor represented the orientation of the robot, and the accumulation of the distances was measured from the rotary encoder [9]. Collision detection and vehicle avoidance in the VANET environment were investigated by Anadu. Physical experiments involved making VANET implemented with microcontrollers, sensor systems, and radio-controlled cars. Integrating all of them resulted in a collision detection system that helped improve traffic efficiency on a small scale. This physical model was executed using Arduino UNO, RGB LCD Shield, GPS Logger Shield, SR04 Ping Distance Sensor, RF 433 MHz Transmitter Module, RF 433 MHz Receiver Module and DC motor [10].

Based on previous research, the use of proximity sensors in this paper is different from previous studies. Previous researchers to determine a distance using ultrasonic sensors SRF04, IMU, GPS, and Infrared. Ultrasonic sensors with PIR sensors are used to detect the distance of people watching TV. In addition, this paper presents a proximity sensor combined with a fuzzy decision tree algorithm for the detection of a standard distance for TV use.
2. Method
The system designed includes hardware and software that provide standard TV viewing information and give a warning if the distance is less than the internationally defined standard. The system diagram block is shown in figure 1.

![System block diagram](image1)

**Figure 1.** System block diagram

The working principle of the block diagram shown in Figure 1. A keypad is used to enter the type of television namely the screen width in inches used as the input from the microcontroller [11], [12], [21], [13]–[20]. When there is an object that does not emit infrared rays exposed to the ultrasonic sensor[22]–[28], the LCD shows the distance of the object to the TV. When there is an object that emits infrared light, as long as the distance is met, the LED will turn off and the buzzer will not ring. When the standard distance is not met, the LED will blink and the buzzer will sound, and when the warning given is more than 10 seconds, the relay will work and turn off the power from the television automatically.

2.1. Hardware design
The device in a wiring system along with the devices and electrical components used shown in Figure 2. It can be seen in the figure that the system consists of an Arduino Uno [11], [29], [38]–[43], [30]–[37] development board used as the controller for the entire workflow of this device, a 4x8 keypad module used as an input for programming variables, a 16x2 LCD used as programming variable data viewer, a buzzer circuit as an indicator of control conditions, and a relay circuit to control the on/off of the television.

![System wiring diagram](image2)

**Figure 2.** System wiring diagram

2.2. Software design
The programming design is explained in the workflow diagram shown in Figure 3. The diagram shows that the first pin initialization namely Arduino pins used for LCD, keypad, PIR, buzzer, and
ultrasonic sensors has been done. After that library declarations and variables are used in the software program. The second stage is the program opening screen to set TV size options. Then the third is the main program to read the condition of the proximity sensor logic and the process of displaying distance on the LCD. After the distance processing and displaying it on the LCD, there are sub-programs as safe distance detectors that are distinguished by the size of the television used and infrared sensor detectors to detect the presence of living things. If the object has exceeded the safe limit of watching television, the buzzer and LED give a warning based on the distance of the object, if the warning process is ignored for more than 10 seconds, the relay will be activated to turn off the television. But if it meets the safe distance again, the relay will be deactivated so that the television turns on again.

![System workflow diagram](image)

**Figure 3.** System workflow diagram.

3. Implementation

At this stage 2 test implementations were carried out namely testing the sensor and the whole device. Sensor testing is performed to determine the accuracy of detection and measurement, while the device testing is performed to determine the actual performance of the tool in the field.
3.1. Sensor testing

This test was conducted on two sensors namely PIR and ultrasonic sensors. The PIR sensor is performed to adjust the sensitivity in the minimal position with variations in height and angle of measurement. In testing with a height of 75 cm from the floor, the state of the PIR sensor is always appropriate and accurate to the distance from the TV. As for testing the distance with ultrasonic sensors was carried out by varying the distance of the sensor from the TV compared to the measurement of standard measuring instruments. This test shows a maximum error of 0.15% and an accuracy rate of 98%.

3.2. Testing tool

Device testing is performed to determine the success of the overall performance of the hardware and software designed. This test is carried out with 3 television size variations, namely; 14 inches, 17 inches and 20 inches.

Table 1. Table for 14 Inch television testing

| No. | Watching Distance (cm) | Device Condition | TV Condition |
|-----|------------------------|------------------|--------------|
| 1   | 160                    | Normal           | On           |
| 2   | 140                    | LED blink (medium) & Beep (low frequency) | On |
| 3   | 120                    | LED blink (faster) & Beep (medium frequency) | On |
| 4   | 40                     | LED blink (very fast) & Beep (high frequency) | Off |

In this variation, the device performance is in accordance with the design and workflow.

Table 2. Table for 17 Inch television testing

| No. | Watching Distance (cm) | Device Condition | TV Condition |
|-----|------------------------|------------------|--------------|
| 1   | 200                    | Normal           | On           |
| 2   | 180                    | LED blink (medium) & Beep (low frequency) | On |
| 3   | 140                    | LED blink (faster) & Beep (medium frequency) | On |
| 4   | 50                     | LED blink (very fast) & Beep (high frequency) | Off |

In this variation, the device performance is in accordance with the design and workflow.

Table 3. Table for 20 Inch television testing

| No. | Watching Distance (cm) | Device Condition | TV Condition |
|-----|------------------------|------------------|--------------|
| 1   | 255                    | Normal           | On           |
| 2   | 200                    | LED blink (medium) & Beep (low frequency) | On |
| 3   | 170                    | LED blink (faster) & Beep (medium frequency) | On |
| 4   | 75                     | LED blink (very fast) & Beep (high frequency) | Off |

In this variation, the device performance is in accordance with the design and workflow.

4. Conclusion

Having designed, implemented and tested the device, it can be concluded that the device has been running normally in accordance with the purpose of the study namely measuring the distance of television viewers to objects. The results of the 14inch television testing at the distance of 160 cm, the television is still on and at the distance of 45 cm and 40 cm the television is off. The 17inch television testing at the distance of 200 cm, the television is still on and at the distance of 48 cm the television is off. The test results of a 20inch television testing at the distance of 255 cm, the television is still on and at the distance of 75 cm, the television is off. The distance that make the television off is 50 cm and closer for either 14inch, 17inch, or 20inch televisions.

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