Blind people's direction support system using ultrasonic, color sensor with fuzzy logic

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Abstract. Someone who has impaired vision or blindness has a condition that is susceptible to dangers that are around him such as the presence of animals, vehicles or obstructions. People with visual impairments carry out their activities based on estimates of their feelings. One obstacle that is often faced by blind people is that if they are in a new environment, they must recognize patterns around the environment such as roads, rooms, or certain important places. His research in the form of blind shoe design using ultrasonic, color sensor and Arduino Uno microcontroller, with fuzzy logic, aims to help blind people, especially children who are educated in extraordinary schools so that in carrying out their learning activities do not experience obstacles in recognizing the school environment, such as study rooms or classrooms, toilets and roads that are in the school environment. The method used is experimental, the color sensor can read input in the form of red, blue, green and yellow which is the blind pointing pathway, and ultrasonic can read the distance of obstacles in front of the shoe using an intelligent fuzzy logic system. A pair of shoes uses Bluetooth communication, output in the form of sound through earphones as a guide to the classroom or toilet.

1. Introduction

Vision is one of the most important five senses, functioning as the recipient of information received directly by way of seeing. Visual impairment in the form of blindness causes blind people who are not free to move or do daily activities so that a tool designed to help blind people to facilitate their activities, especially when walking, and reduce the risk of persons with danger around them.

As a direction when walking the blind shoes are designed using color sensors, ultrasonic sensors, Arduino microcontrollers, Bluetooth and earphones. The color sensor is used to detect an object, objects, colors or the surrounding environment. The use of color sensors as exploration and mapping of autonomy, the determination of octree-based localization in indoor robots [1], [2]. Another advantage of the color sensor is that it can track objects for pizza chef robots with RGB-D [3]. Offline programming using RGB on cell dispensing robots [4]. In this design, ultrasonic sensors are used to detect distances that function as identification of obstacles or hazards, other uses as detection of underwater objects [5], as detection of structural changes on the bridge [6], to detect traffic participants in low-speed traffic situations [7]. Fuzzy logic engineering is needed for the classification of RGB colors as input systems [8] The fuzzy logic approach is very precisely applied to tracking...
multiple visual objects [9], for fast and efficient color enhancement based on fuzzy logic and histograms [10].

2. System Design

The design of a pointing system for people with visual impairment in (figure 1) includes a series of ultrasonic sensors, TCS230 color sensors, fuzzy logic and programming of an Arduino microcontroller.

![Figure 1. System design](image)

2.1. Color sensor

TCS230 color sensor is a color sensor that is often used in microcontroller applications to detect an object or the color of an object being monitored. The TCS230 color sensor can also be used as a motion sensor, where the sensor detects the movement of an object based on the color changes received by the sensor.

![Figure 2. TCS230 color sensor](image)

Color sensor with input in the form of red, green, blue and yellow. The sensor is exposed to the color and the reading results will be seen on the serial monitor with the provisions of the RGB value.

| No | Color | R,G,B Output Value |
|----|-------|-------------------|
| 1  | ![Red](image) | 2,15,10           |
| 2  | ![Light Pink](image) | 5,21,15           |
| 3  | ![Pink](image) | 9,37,30           |
The (table 1) shows the RGB value of each red color that is detected as a value of each in pink R values tend to be lower than red because of the lack of red content contained in the object being detected.

| No | Color | R,G,B Output Value |
|----|-------|-------------------|
| 4  | 12,43,38 |
| 5  | 15,52,46 |
| 6  | 25,70,85 |
| 7  | 30,74,80 |
| 8  | 33,77,70 |
| 9  | 38,85,76 |
| 10 | 43,89,80 |

The (table 2) shows the RGB value of each red color detected has a value of each in light green color G values tend to be lower than the green color because of the lack of green content contained in the object being detected.

| No | Color | R,G,B Output Value |
|----|-------|-------------------|
| 1  | 5,3,9  |
| 2  | 7,3,8  |
| 3  | 10,7,17 |
| 4  | 15,7,17 |
| 5  | 22,17,26 |
| 6  | 32,23,29 |
| 7  | 33,22,25 |
| 8  | 33,26,30 |
| 9  | 35,30,33 |
| 10 | 39,28,35 |

The (table 3) shows the RGB value of each red color detected has a value of each in blue R,G,B values tend to be lower than blue because of the lack of blue content contained in the object being detected.

| No | Color | R,G,B Output Value |
|----|-------|-------------------|
| 1  | 14,10,2 |
| 2  | 21,14,2 |
| 3  | 28,18,3 |
| 4  | 32,25,9 |
| 5  | 45,31,15 |
| 6  | 45,33,16 |
| 7  | 48,31,17 |
| 8  | 51,35,20 |
| 9  | 57,40,22 |
| 10 | 60,44,28 |
Table 3 shows the RGB value of each red color detected has a value of each in the light blue color B values tend to be lower than the blue color because of the lack of blue content contained in the object being detected.

2.2. Ultrasonic Sensor
Ultrasonic sensors can detect the distance of an object by emitting ultrasonic waves with a frequency of 40 KHz, then detect the reflection. The HC-SR04 Ultrasonic Sensor is faced perpendicular to an obstacle in the form of the paper with a smooth surface at a certain distance. Figure 3 shows an ultrasonic sensor.

![Ultrasonic Sensor](image)

**Figure 3. Ultrasonic Sensor**

2.3. Fuzzy logic
The process of the fuzzy logic method is divided into three, namely: fuzzification, rule evaluation, and defuzzification. (figure 4) is the process of the fuzzy method of blind shoes. The fuzzification stage is divided into 2 groups, namely color sensor fuzzification and ultrasonic sensor fuzzification.

![Fuzzy logic process](image)

**Figure 4. Fuzzy logic process**
The color sensor has 3 Red, Green and Blue (RGB) output conditions, each of which has an output value. Figures 5, 6 and 7 show the membership function of the input colors Red, Green and Blue on fuzzy-MATLAB.

**Figure 5.** Membership input is red

**Figure 6.** Membership input is green

**Figure 7.** Membership input is Blue

Ultrasonic sensors make the distance as a membership to function as a barrier detection. Obstacles are determined with a range of 0 - 200 cm, if the person is at a distance of 40 cm then that is said to be safe or is far from the obstacle, but if the person is at a distance of 15 cm to 22.5 cm then it is said that the distance is not safe or in a condition very close to the obstacle.

**Figure 8.** Distance input membership
From the rule evaluation we will know the output conditions of the RGB value and distance. At (table 4) shows the evaluation rule.

| No. | Color | Distance | Output  |
|-----|-------|----------|---------|
| 1   | Low (15) | High (50) | High (40) | Very close (30 cm) | WAV2 |
| 2   | Low (15) | High (50) | High (40) | Close (40 cm) | WAV2 |
| 3   | Low (15) | High (50) | High (40) | Far (60 cm) | WAV1 |
| 4   | Low (15) | High (50) | High (40) | Very far (70 cm) | WAV1 |
| 5   | High (23) | Low (18) | High (25) | Very close (30 cm) | WAV2 |
| 6   | High (23) | Low (18) | High (25) | Close (40 cm) | WAV2 |
| 7   | High (23) | Low (18) | High (25) | Far (60 cm) | WAV4 |
| 8   | High (23) | Low (18) | High (25) | Very far (70 cm) | WAV4 |
| 9   | High (34) | High (23) | Low (7) | Very close (30 cm) | WAV2 |
| 10  | High (34) | High (23) | Low (7) | Close (40 cm) | WAV2 |
| 11  | High (34) | High (23) | Low (7) | Far (60 cm) | WAV3 |
| 12  | High (34) | High (23) | Low (7) | Very far (70 cm) | WAV3 |
| 13  | Low (24) | Low (12) | High (65) | Very close (30 cm) | WAV2 |
| 14  | Low (24) | Low (12) | High (65) | Close (40 cm) | WAV2 |
| 15  | Low (24) | Low (12) | High (65) | Far (60 cm) | - |
| 16  | Low (24) | Low (12) | High (65) | Very far (70 cm) | - |

Defuzzification produces firm values in the form of sound output produced according to the conditions of the blind shoe. There are five conditions, namely active1 functions when the shoe is outside the path of the blind (red), active2 is the condition where the shoe is facing close to the obstacle, active3 is the condition of the shoe is in the classroom or towards a blue classroom, active4 is the condition of the shoe is located in the toilet room or green, and the last one is active0 ie the shoes are in a condition in the lane, so the sound does not come out of earphone. All sounds will sound according to the condition of the shoes are.

2.4. Arduino programming
The blind shoe program in Arduino has been combined with an ultrasonic sensor program, useful when the blind shoe is faced with obstacles. The blind shoe output is sound. This sound is stored on the sd-card module in the way format, which is the sound recording format that will be issued when the shoe gets a response or input.
3. Result
Figure 10 shows the color sensor and ultrasonic sensor when reading input in the form of color and obstruction. Shoes that have been designed as a direction for people with visual impairment can read red, blue, green, and yellow on the track plan. Shoes can also read distances, so obstacles can be identified. Communication between the right and left shoes using Bluetooth and output in the form of voice information through earphones.

![Image of shoes and sensor setup](image.jpg)

**Figure 10.** Pointing shoes
The implementation of shoes as a direction is used for children with visual impairment in Special Schools (SLB). The path used is the path that is given color according to the sensor reading. The lane plan has 4 colors, each of which functions as a sign of location and direction, where children with visual impairment will walk on the yellow lane as a blind lane and the red lane as a marker or warning when leaving the lane.

![Figure 11. Plan direction shoe lane](image)

Table 5 shows information related to the path position, obstacles or identification of hazards given in the form of voice messages via earphones.

| No | Color and distance | Voice      | Function                                                                 |
|----|--------------------|------------|--------------------------------------------------------------------------|
| 1  | Red                | “Out the Path” | Information when people with visual impairment are out of line           |
| 2  | Blue               | “Classroom” | Information when the blind are in front of the classroom                 |
| 3  | Green              | “Toilet”   | Information when people with visual impairment are in front of the bathroom (toilet) |
| 4  | Distance = <40     | “Stop”     | Information when visually impaired people are facing obstacles (hazard identification) |

4. Conclusion
Shoes that are designed as a direction for the blind can function well, the color sensor can read input in the form of red, blue, green, and yellow according to the colors found in the lane plan. Ultrasonic sensors can read distances as identification of obstacles or hazards of a maximum of 300 cm or 3 meters. Fuzzy logic engineering is used in making comparisons to bring up the desired color depending on the output R, G, B values of the color sensor and depending on the distance between the sensor and the color object detected. Development can be done by adding an ultrasonic sensor that is pointing down in order to detect holes, and completing it with GPS as a location detector when people with visual impairment get lost, making it easy to find.
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