TELKOMNIKA Telecommunication, Computing, Electronics and Control
Vol. 18, No. 2, April 2020, pp. 945~952
ISSN: 1693-6930, accredited First Grade by Kemenristekdikti, Decree No: 21/E/KPT/2018
DOI: 10.12928/TELKOMNIKA.v18i2.12419

Glasses for the blind using ping ultrasonic, ATMEGA8535 and ISD25120

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Article Info

Article history:

Received Jan 23, 2019
Revised Dec 3, 2019
Accepted Dec 18, 2019

Keywords:

Glasses
ISD25120
Microcontrollers
Ultrasonic sensor
Voice

ABSTRACT

For doing their activities, blind people need tools. The idea for designing this device is for helping the blind person. This device is a glasses specially for blind person which gives information in the form of voices through an earphone if there is an obstacle in the range of 0–58 cm. The device is using PING ultrasonic sensor, ATMEGA8535 microcontroller, and ISD25120 for recording and saving the voices. After designing and making the device, we tested the device to take the data. We use three PING ultrasonic sensors which are put at the sides of the glasses. The device will give eight different kinds of voices through the earphone. The voices depend upon the output of the PING ultrasonic sensors.

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1. INTRODUCTION

Background: The ability to see is important thing for getting information from environment. If somebody lost his ability to see, then he or she will lose one of important source to get information. By losing his or her ability to see, the blind must depend on the other senses. Problem: The blind people need stick or dog for helping them. We try to give a device that can help them to walk without using stick or a dog. We try to design a device that can help the blind person to overcome his or her disability. This devices could be used by the blind to assist them in their ways without any human assistance. It will be used by the blind to let them walk independently. Before us, there is also glasses for the blind which will be in market in 2016. They were created by researchers at the University of Oxford, who linked up with the Royal National Institute of Blind People (RNIB). At the moment, the glasses are rather bulky. They are also fairly expensive and participants have to carry around a connected laptop with them. There are not many research studies related to this topic. However there are few references that may be used. Hermann Schweizer wrote his paper "Smart Galasses: Technology and Applications" [1]. Andrea Colaco wrote "Sensor Design and Interaction Techniques for Gestural Input to Smart Glasses and Mobile Devices" [2]. M. Iftekhar Tanverr and Mohammed E. Hoque wrote "A Google Glass App to help the Blind in Small Talk" [3]. M. Karthikeyan and SC. Vijayakuma wrote their paper: "Embedded System Using Ultrasonic Wave and Voice Biometric to Build an E-Glass for the Blinds" [4]. Esra Ali Hasan and Tong Boon Tang "Smart Glasses for the Visually Impaired People" [5]. Jinqiang Bai, Shiguo Lian, Zhaoxiang Liu, Kai Wang, and Dijun Liu wrote "Smart Guiding Glasses for Visually Impaired People in Indoor Environment" [6]. Ankita Bhuniya, Sumanta Laha, Deb Kumar Maity, Abhishek Sarkar, and Suvanjan Bhattacharyya wrote "Smart Glass for Blind People" [7].

Mohanapriya R., Nirmala U., and Priscilla CP. wrote “Smart Vision for the Blind People” [8]. Harshita Bhorshetti, Shreyas Ghuge, Athang Kulkarni, Sukhada Bhingarkar, and Netra Lokhande wrote “Low Budget Smart Glasses for Visually Impaired People” [9].

Proposed Solution: We try to design glasses for the blind. We put sensors to detect obstacles near from the blind, and this device will tell the user if there is an obstacle by giving voices to the earphone which is connected. There are eight types of voice which are recorded into ISD25120, which are no sound as sound 0 meaning no obstruction, “Left” as sound 1 meaning there is obstruction on the left, “Right” as sound 2 meaning there is obstruction on the right, “Left and Right” as sound 3 meaning there are obstructions on the left and right, “Front” as sound 4 meaning there is obstruction in front, “Front and Left” as sound 5 meaning there are obstructions in front and on the left, “Front and Right” as sound 6 meaning there are obstructions in front and on the right, “Front, Left, and Right” as sound 7 meaning there are obstructions in front, on the left, and on the right. This will help the blind people to know which side there is an obstruction.

2. RESEARCH METHOD

2.1. Atmega 8535 microcontroller

For this device, we are using Atmega 8535 microcontroller. The ATmega8535 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing instructions in a single clock cycle, the ATmega8535 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers. All 32 registers are directly connected to the arithmetic logic unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. Figure 1 is showing the Atmega 8535 pin configuration.

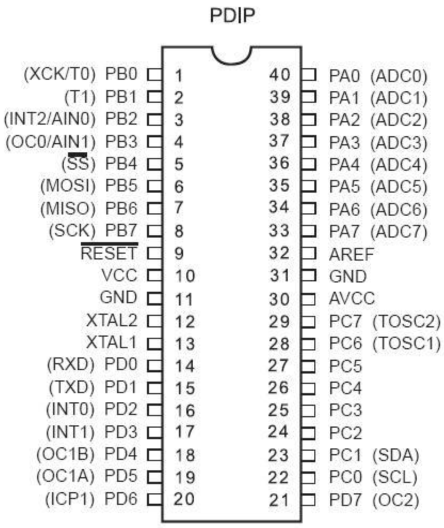

Figure 1. Atmega 8535 Pin Configuration [10, 11]

2.2. Ultrasonic sensor

The ultrasonic sensor block provides the input for the microcontroller. Ultrasonic is sound with a frequency greater than the upper limit of human hearing (greater than 20 kHz) [12, 13]. The speed of sound depends on the medium the waves pass through, and is a fundamental property of the material. For example, the speed of sound in gases depends on temperature. The speed of sound at 20°C (68°F) air at sea level is approximately 343.37 m/s [14, 15].

Ultrasonic sensors are sensors that work on the principle of the reflection of sound waves, where this sensor produces sound waves which then catch it back with time difference as the basis of sensing. The time difference between the sound waves emitted by the recaptured sound waves is directly proportional to the distance or height of the object that reflects it. Types of objects that can be sensed include: solid objects, liquid, granules and textiles. Figure 2 is showing how ultrasonic sensor works.

Ultrasonic sensor is a sensor that utilizes ultrasonic wave emission. This ultrasonic sensor consists of an ultrasonic transmitter circuit called a transmitter and an ultrasonic receiver circuit called a receiver. Ultrasound sensors are very versatile in distance measurement. They are also providing the cheapest solutions. Ultrasound waves are useful for both the air and underwater. Ultrasonic sensors are also quite fast for most of the common applications [16-18].

2.3. PING

The Parallax PING))) sensor is used in this project. It provides precise, non-contact distance measurements from about 2 cm to 3 meters [19]. The Parallax PING sensor detects objects by emitting a short ultrasonic burst and then receiving the echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short ultrasonic burst (40 kHz). This burst travels through the air, hits an object and then bounces back to the sensor. The sensor provides an output pulse to the host that will terminate when the echo is detected, and the width of this pulse corresponds to the distance to the target. The Parallax PING sensor has a male 3-pin header used to supply power (5 V), ground (GND), and signal [20, 21]. Figure 3 is showing the PING))) sensor.

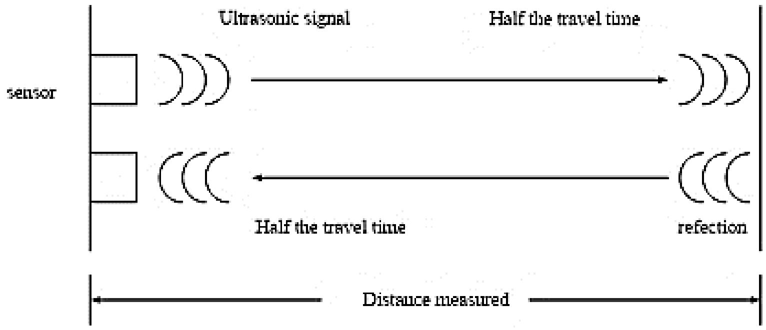

Figure 2. How ultrasonic sensors work [22-24]

Figure 3. The PING))) sensor

2.4. Sound recorder IC ISD25120

Figure 4 is showing ISD25120 device pinouts. This voice recording IC is a type of ISD 25120, this IC has 28 pin and this IC has 480 kB internal memory and supplied with voltage of 5V DC. The IC is capable of storing sounds within a duration of 120 seconds. Regarding the details and functions of the pin, we can see on the IC data sheet. This voice recording serves as a notification to be played when each sensor is attached to the device, sensing the presence of nearby objects. There will be some sound recorded on this IC with a total duration of 120 seconds, the resulting sound will depend on the input of the sensor processed on the microcontroller IC [25].

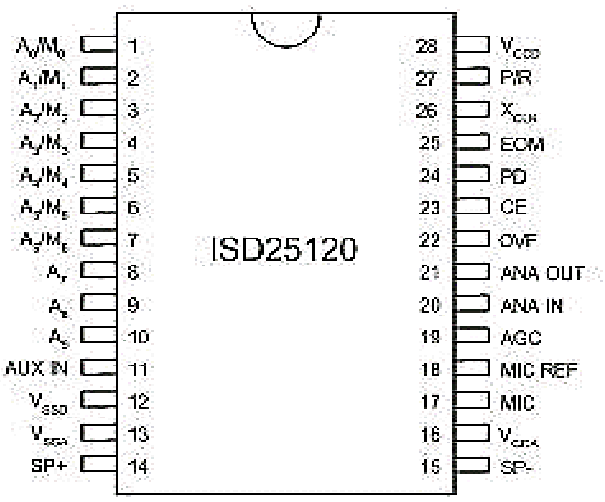

Figure 4. ISD25120 device pinouts

2.5. Research

This tool is designed using ultrasonic sensors PING as sensors, microcontroller as a circuit brain that serves to process the sensed data, and ISD25120 voice recording IC as a voice recorder so that this tool can produce sound in accordance with the results of sensor sensing PING. With the sound produced, then this tool will be easier to use and more easily understood by the blind person. As shown in Figure 5 the Block Diagram, we have 3 PING sensor to detect the obstacles in front, right, and left. The output of the PING sensor will be as inputs to the Microcontroller ATMEGA 8535. Output of the microcontroller will go to Sound Recorder ISD25120, and then will give the sound through speaker.

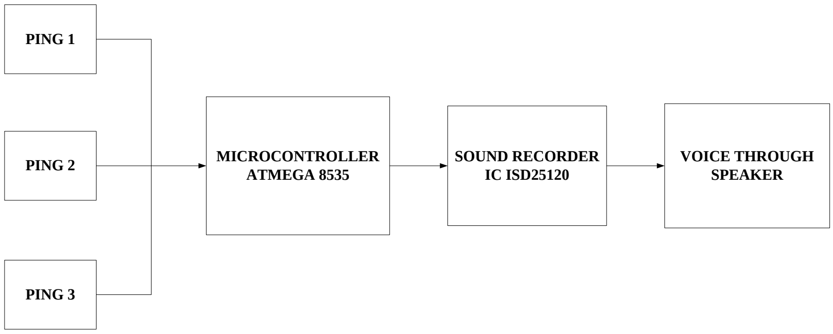

Figure 5. Block diagram of the system tool design

It is designed with PING ultrasonic sensors mounted on three sides of the glasses, ie the front (sensor 1), the right side (sensor 2), and the left side (sensor 3). Each sensor will detect objects around at a distance 0 to 60 cm from the glasses, which further results of sensing are processed on IC microcontroller that serves as the brain circuit using the C language as a programming language, and is connected to the speakers to produces sound output. The resulting sound, whuch is previously recorded on a tool IC ISD25120, and the results of processing on the microcontoller that determines the results of its voice. Microcontroller used in this tool is ATMEGA8535 microcontroller that serves as a data processing enter which will determine which sounds will be issued, depending on the insert sensor received. There are 8 conditions that will produce different output sounds, depending on the state of the sensor.

If the sensor senses an object at a distance between 0-60 cm from the sensor then the sensor will give input 1 and if the sensor does not sense the object at a distance between 0-60 cm from the sensor then the sensor will give input in the form of 0, or assumed there is no object in near the sensor on the microcontroller, then input received from the three sensors PING will be processed by the microcontroller to call the sound previously recorded and stored on the ISD25120 voice recording IC, sound that has been recorded will be issued by the speaker. The programming language used in this ATMEGA8535 microcontroller uses C language. In Table 1 the following sound design is generated according to the sensing state of the PING sensor at a distance of 0-60 cm from the sensor, where 1=sensor senses the object while the 0 = sensor does not sense the object.

Table 1. Sound design generated under certain sensor conditions

Obstacles Given			Output Sound
PING 1	PING 2	PING 3	
0	0	0	Sound 0
0	0	1	Sound 1
0	1	0	Sound 2
0	1	1	Sound 3
1	0	0	Sound 4
1	0	1	Sound 5
1	1	0	Sound 6
1	1	1	Sound 7

The resulting sound will depend on the sensor sensing results of the PING mounted on the glasses. There are 8 sound conditions generated based on sensor sensing results of PING. Figure 6 shows the program's flowchart image on the microcontroller and Figure 7 is an ISD25120 sound recording IC circuit image that also integrates with the speaker as a sound producer.

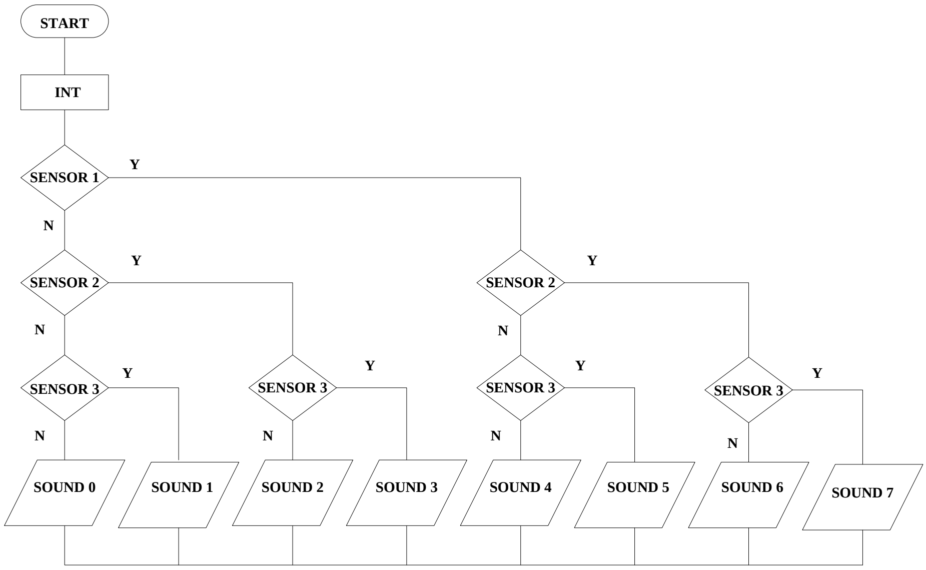

Figure 6. Program flowchart

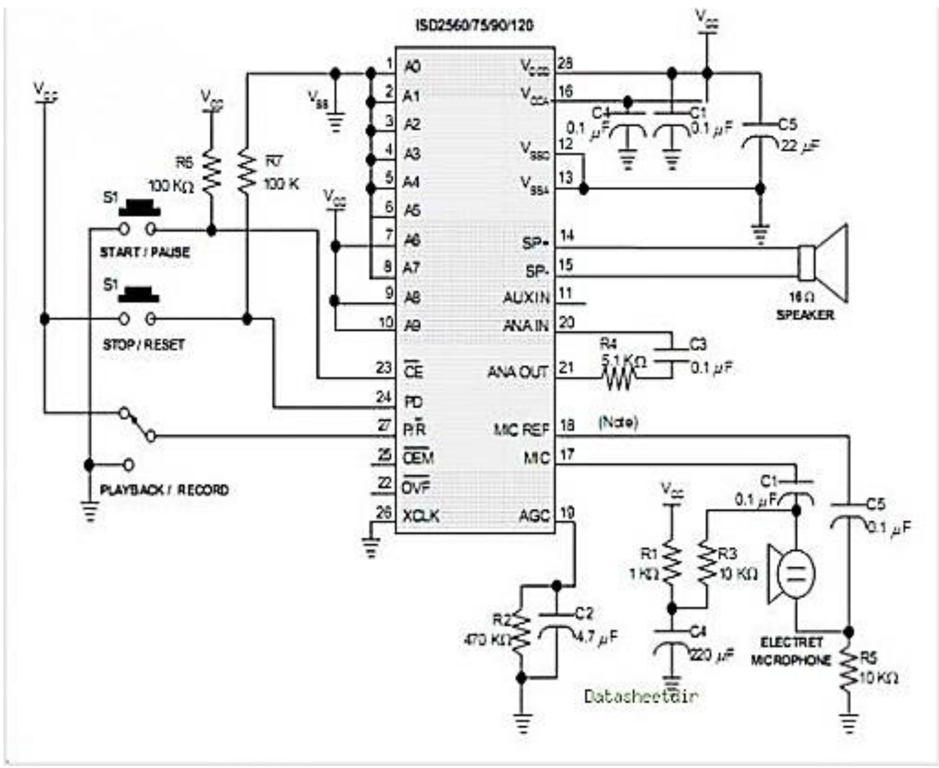

Figure 7. ISD25120 sound recorder IC

3. EXPERIMENT RESULTS AND DISCUSSION

3.1. Experiment results

The experiment is to provide obstacles at the distance between 0 60 cm and at a distance > 60 cm from the glasses (sensor PING) on each sensor according to data as in Table 2, where 1 = sensor is given obstacle, and 0 = sensor not given obstacle. By giving obstacles to each sensor according to Table 2, and experiment 6 times with different distance 15 cm, 30 cm, 45 cm, 58 cm, 60 cm so that the experimental data obtained as shown in the following Tables 3, 4, 5, 6, 7, and 8. From the data in Tables 7 and 8, ie in experiments with obstacles at a distance of 60 cm and 75 cm, the sensor assumes there is not any object; therefore, it produces Sound 0 only.

Table 2. Giving obstacles to each sensor

Obstacles are provided on the distance 0-60 cm		
PING 1	PING 2	PING 3
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Table 3. Experimental data with obstruction at 15 cm distance

Obstruction Given			Sound
Ping 1 Front	Ping 1 Right	Ping 1 Left	
0	0	0	Sound 0, No obstruction
0	0	1	Sound 1, Obstruction on the left
0	1	0	Sound 2, Obstruction on the right
0	1	1	Sound 3, Obstruction on the left and right
1	0	0	Sound 4, Obstruction in front
1	0	1	Sound 5, Obstruction in front and on the left
1	1	0	Sound 6, Obstruction in front and on the right
1	1	1	Sound 7, Obstruction in front, on the right, and on the left

Table 4. Experimental data with obstruction at 30 cm distance

Obstruction Given			Sound
PING 1 Front	PING 1Right	PING 1 Left	
0	0	0	Sound 0, No obstruction
0	0	1	Sound 1, Obstruction on the left
0	1	0	Sound 2, Obstruction on the right
0	1	1	Sound 3, Obstruction on the left and right
1	0	0	Sound 4, Obstruction in front
1	0	1	Sound 5, Obstruction in front and on the left
1	1	0	Sound 6, Obstruction in front and on the right
1	1	1	Sound 7, Obstruction in front, on the right, and on the left

Table 5. Experimental data with obstruction at 45 cm distance

Obstruction Given			Sound
Ping 1 Front	Ping 1 Right	Ping 1 Left	
0	0	0	Sound 0, No obstruction
0	0	1	Sound 1, Obstruction on the left
0	1	0	Sound 2, Obstruction on the right
0	1	1	Sound 3, Obstruction on the left and right
1	0	0	Sound 4, Obstruction in front
1	0	1	Sound 5, Obstruction in front and on the left
1	1	0	Sound 6, Obstruction in front and on the right
1	1	1	Sound 7, Obstruction in front, on the right, and on the left

Table 6. Experimental data with obstruction at 58 cm distance

Obstruction Given			Sound
Ping 1 Front	Ping 1 Right	Ping 1 Left	
0	0	0	Sound 0, No obstruction
0	0	1	Sound 1, Obstruction on the left
0	1	0	Sound 2, Obstruction on the right
0	1	1	Sound 3, Obstruction on the left and right
1	0	0	Sound 4, Obstruction in front
1	0	1	Sound 5, Obstruction in front and on the left
1	1	0	Sound 6, Obstruction in front and on the right
1	1	1	Sound 7, Obstruction in front, on the right, and on the left

Table 7. Experimental data with obstruction at 60 cm distance

Obstruction Given			Sound
Ping 1 Front	Ping 1 Right	Ping 1 Left	
0	0	0	Sound 0, No obstruction
0	0	1	Sound 0, No obstruction
0	1	0	Sound 0, No obstruction
0	1	1	Sound 0, No obstruction
1	0	0	Sound 0, No obstruction
1	0	1	Sound 0, No obstruction
1	1	0	Sound 0, No obstruction
1	1	1	Sound 0, No obstruction

Table 8. Experimental data with obstruction at 75 cm distance

Obstruction Given			Sound
Ping 1 Front	Ping 1 Right	Ping 1 Left	
0	0	0	Sound 0, No obstruction
0	0	1	Sound 0, No obstruction
0	1	0	Sound 0, No obstruction
0	1	1	Sound 0, No obstruction
1	0	0	Sound 0, No obstruction
1	0	1	Sound 0, No obstruction
1	1	0	Sound 0, No obstruction
1	1	1	Sound 0, No obstruction

3.2. Discussion

From the above experimental data, it can be made an analysis that the sensors will only perceive objects-objects around at a certain distance that is at a distance between 0 to 58 cm from the sensor PING (glasses), while objects are spaced above 58 cm from PING (glasses) sensors are considered non-existent. There are 8 sound conditions generated based on the sensing results of the three sensors mounted on the glasses, with the position of the sensor in front, right side, and left side. This tool only senses the objects that are in front, right side, and the left side of the tool.

The resulting sound is based on previously recorded sound on the ISD25120 sound recording IC. IC ISD25120 has the function as a voice recorder and as a voice player that has been recorded. The sound naming in the table (sound 1, sound 2, etc.), is merely a sound security sequence on this ISD25120 IC. There are eight types of voice which are recorded into ISD25120, which are no sound as sound 0 meaning no obstruction, “Left” as sound 1 meaning there is obstruction on the left, “Right” as sound 2 meaning there is obstruction on the right, “Left and Right” as sound 3 meaning there are obstructions on the left and right, “Front” as sound 4 meaning there is obstruction in front, “Front and Left” as sound 5 meaning there are obstructions in front and on the left, “Front and Right” as sound 6 meaning there are obstructions in front and on the right, “Front, Left, and Right” as sound 7 meaning there are obstructions in front, on the left, and on the right. This will help the blind people to know which side there is an obstruction.

4. CONCLUSION

In this tool, we used 3 sensors placed on the front (sensor 1), right side (sensor 2), and left side (sensor 3) glasses, where each sensor is connected to ATMEGA8535 microcontroller, which then controls to call sound on ISD25120 if the sensor senses obstacles or objects. There are 8 sound conditions generated based on the sensing results of the three PING sensors mounted on this glasses. The previously generated sound is recorded on the ISD25120 sound recording IC; therefore, when the combination of the three sensors is on, the program on the microcontroller only calls the recorded sound. Overall this tool can work well if objects or obstacles are in the position up to a distance of 58 cm from the tool.

REFERENCES

[1] Schweizer H., “Smart Glasses: Technology and Applications,” Student report Ubiquitous Computing Seminar FS2014, pp. 1-5, 2014.

[2] Colaco, A., “Sensor Design and Interaction Techniques for Gestural Input to Smart Glasses and Mobile Devices,” *The 26th Annual ACM Symposium on User Interface Software and Technology*, St. Andrewsm United Kingdom, pp. 49-52, October 2013.

[3] Tanverr M. I., Hoque M. E., “A Google Glass App to Help the Blind in Small Talk,” *The 16th International ACM SIGACCESS Conference on Computers & Accessibility*, Rochester, NewYork, USA, pp. 297-298, October 2014.

[4] Karthikeyan M., Vijayakumar S. C., “Embedded System Using Ultrasonic Wave and Voice Biometric to Build an E-Glass for the Blinds,” *International Journal of Engineering Research & Technology (IJERT)*, vol. 3, no. 1, pp. 500-504, 2014.

[5] Hasan E. A., Tong B. T., “Smart Glasses for the Visually Impaired People,” *The 15th International Conference on Computer Helping People with Special Needs (ICCHP)*, Linz, Austria, pp. 579-582, July 2016.

[6] Bai, J., Lian, S., Liu, Z., Wang, K., Liu, D., “Smart Guiding Glasses for Visually Impaired People in Indoor Environment," *in IEEE Transactions on Consumer Electronics*, vol. 63, no. 3, pp. 258-266, August 2017.

[7] Bhuniya A., Laha S., Maity DK., Sarkar A., Bhattacharyya S., “Smart Glass for Blind People,” *AMSE JOURNALS-AMSE IIETA*, vol. 38, no. 1, pp. 102-110, 2017.

[8] Mohanapriya R., Nirmala U., Priscilla C. P., “Smart Vision for the Blind People,” *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)*, vol. 5, no. 7, pp. 2014-2017, July 2016.

[9] Bhorshetti B., Ghuge S., Kulkarni A., Bhingarkar S., Lokhande N., “Low Budget Smart Glasses for Visually Impaired People,” *IOSR Journal of Engineering (IOSRJEN)*, pp. 48-52, 2019.

[10] Syafaruddin, Andani Achmad, Tajuddin Waris, Zulkifli Tahir, Yulianto Dwi Putra, “Application of Microcontroller ATmega8535 for Hybrid Photovoltaic–Thermal (PV/T),” *International Journal of Engineering and Technology (IJET)*, vol. 5, no. 5, pp. 4388-4399, November 2013.

[11] Adris, Wibowo E. P. T., Sumari A. D. W., “Design and Implementation of Security System Based on ATMega8535 Microcontroller,” *The 1st Makassar International Conference on Electrical Engineering and Informatics*, pp. 88-91, November 2008.

[12] Kun Tseng W., “A Directional Audible Sound System using Ultrasonic Transducers,” *International Journal of Advanced Research in Artificial Intelligence*, vol. 4, no. 9, pp. 11-16, September 2015.

[13] Carullo, A., Parvis, M., “An ultrasonic sensor for distance measurement in automotive applications,” *IEEE Sensors Journal*, vol. 1, no. 2, pp. 143-, Aug 2001.

[14] Bohn D. A., “Environmental Effects on the Speed of Sound,” *Journal of the Audio Engineering Society*, vol. 36, no. 4, pp. 223-231, April 1988.

[15] Krout, K. A., Sohrab, S. H., “On the Speed of Sound,” *International Journal of Thermodynamics*, vol. 19, no. 1, pp. 29-34, 2016.
[16] Shrivastava A. K., Verma A., Singh S. P., “Distance Measurement of an Object or Obstacle by Ultrasound Sensors using P89C51RD2,” *International Journal of Computer Theory and Engineering*, vol. 2, no. 1, pp. 64-68, January 2009.
[17] Titlee, R., Bhuyan, M. H., “Design, Implementation and Testing of Ultrasonic High Precision Contactless Distance Measurement System Using Microcontroller,” *SEU Journal of Science and Engineering*, vol. 10, no. 2, pp. 6-11, December 2016.
[18] Abdullah, R. H., “Design and Implementation of Ultrasonic Based Distance Measurement Embedded System with Temperature Compensation,” *International Journal of Emerging Science and Engineering*, vol. 4, no. 8, pp. 30-37, June 2015.
[19] Stănescu T., Moldovan E. C., Dolga V., “Effects of the Environment Temperature on the Characteristic of Parallax Ping))) Ultrasonic Sensor,” *Robotica& Management*, vol. 19, no. 2, pp. 39-44, 2014.
[20] Tarulescu R., “Usage of Parallax Ultrasonic Sensors in Distance Measurements,” *Annals of the Oradea University Fascicle of Management and Technological Engineering*, no. 1, pp. 393-396, May 2013.
[21] Yalung, C. N., Adolfo, C. M. S., “Analysis of Obstacle Detection Using Ultrasonic Sensor,” *International Research Journal of Engineering and Technolog*, vol 4, no. 1, pp. 1015-1019, January 2017.
[22] Zhmud, V. A., Kondratiev, N. O., Kuznetsov, K. A., Trubin, V. G., Dimitrov. I. V., “Application of Ultrasonic Sensor for Measuring Distances in Robotics,” *Journal of Physics Conference Series*, vol. 1015, no. 3, May 2018.
[23] Wang, S., Liu, Q., Chen, S., Xue, Y., “Design and Application of Distance Measure Ultrasonic Sensor,” *Advances in Mechanical and Electronic Engineering*, vol 178, pp. 109-114, 2013.
[24] Park, J., Je, Y., Lee, H., Moon, W., “Design of an Ultrasonic Sensor for Measuring Distance and Detecting Obstacles,” *Ultrasonics*vol. 50, no. 3, pp. 340-346, March 2010.
[25] Chellaiah R., Venkatesh K., “Temperature Compensated Ultrasonic Ranging for Blind Person with Redundancy System,” *International Journal of Engineering Research & Technology (IJERT)*, vol. 3, no. 10, pp. 115-118, October 2014.

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